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ANNUAL REPORT

OF THE

NATIONAL BOARD OF HEALTH.

1882.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1883.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

The annual report of operations and expenditures of the National Board of Health for the fiscal year ended June 30, 1882.

DECEMBER 6, 1882.—Referred to the Select Committee on Epidemic Diseases and ordered to be printed.

TREASURY DEPARTMENT,
December 5, 1882.

Hon. DAVID DAVIS,
President pro tempore United States Senate:

SIR: In compliance with the requirements of section 4 of the act of June 2 1879 (21 Stat., p. 6), I have the honor to transmit herewith the annual report of operations and expenditures of the National Board of Health for the fiscal year ended June 30, 1882.

Very respectfully,

CHAS. J. FOLGER,
Secretary.

THE NATIONAL BOARD OF HEALTH.

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STEPHEN SMITH, M. D., &c.....*Vice-President.*
CHARLES SMART, Major and Surgeon United States Army.....*Secretary.*

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CHARLES SMART, M. D., United States Army, 1313 N street, Washington, D. C.

W. P. DUNWOODY, Chief Clerk and Disbursing Agent, 30 Grant Place, Washington, D. C.

TABLE OF CONTENTS.

	Page.
Annual Report National Board of Health	7–47
Reports and papers:	
Appendix A.—Report of Drs. H. C. Wood and H. F. Formad on the relations of diphtheria to septic diseases	51–133
Appendix B.—1. Report of George E. Waring, jr., S. E., on the siphonage of traps	135–145
2. Report of E. S. Philbrick and E. W. Bowditch on the siphonage of traps	146–152
Appendix C.—Report of E. W. Bowditch on the sanitary condition of summer resorts	153–187
Appendix D.—Report of Professor Mallet on water analysis, with a supplementary report by Dr. Charles Smart, U. S. A.	189–353
Appendix E.—Report of Dr. J. S. Billings on registration and vital statistics	355–461
Appendix F.—Correspondence with the governor of Louisiana relative to measures to be adopted to prevent the introduction of yellow fever	463
Appendix G.—Report of Dr. T. S. Scales, superintendent of Ship Island refuge station	465–473
Appendix H.—Report of Dr. W. H. Elliott, superintendent of Sapelo refuge station	475–476
Appendix I.—Report of Dr. Stephen Smith on the maritime sanitary service, &c	477–484
Appendix K.—Report of Dr. Fayette Dunlap, superintendent of the Mississippi River inspection service	485–487
Appendix L.—Report of Dr. S. E. Chaillé, supervising inspector at New Orleans	489–543
Appendix M.—Report on the inspection of immigrants	545–569
Appendix N.—Correspondence and report of the commission relative to the establishment of a national quarantine station on the Pacific coast	571–578
Appendix O.—Report of Professor Pumpelly on the filtering capacity of soils	579–664

REPORT

OF

THE NATIONAL BOARD OF HEALTH.

NATIONAL BOARD OF HEALTH,
Washington, D. C., November 13, 1882.

SIR: In accordance with the requirements of section 4 of the act approved June 2, 1879, entitled "An act to prevent the introduction of contagious and infectious diseases into the United States," the National Board of Health respectfully submits its fourth annual report.

SPECIAL SCIENTIFIC INVESTIGATIONS.

Since the date of the last annual report the following-named investigations have been in progress until some of them were finally completed, and others were arrested at the close of the last fiscal year, August 7, 1882, by reason of the failure of Congress to make any provision in the sundry civil appropriation bill for their continuance:

I. Final memoir of Drs. H. C. Wood and H. F. Formad, of Philadelphia, on the relations of diphtheria to other septic diseases. Appendix A.

The results reported seem to prove that diphtheria is a septic sore throat, dependent upon micrococci, which may be developed in an active state from the inert organisms always present in the mouth, or which may find entrance from without; that in scarlet fever, measles, and other affections, similar organisms exist in the blood in malignant cases, and may cause death after the original disease has spent itself, the patient dying of a secondary septicæmia; that so far as the observers can make out there is no difference between this micrococcus and *M. septicus* of Cohn; that an important aid to prognosis is afforded by a study of the blood: whenever the peculiar vacuoles we find in the white blood corpuscles are present death is almost inevitable, and so long as in the advanced stages of the exanthemata these vacuoles are absent the situation is hopeful.

These results are full of interest and are extremely important. It only remains to ascertain the conditions under which "the inert organisms always present in the mouth" or the same organisms introduced from without are developed into the "active state," and we shall, in all probability, have it in our power to apply absolutely preventive measures against a domestic scourge, which is far more destructive in the long run than either cholera or yellow fever.

II. An investigation by George E. Waring, Jr., sanitary engineer, and by Edward S. Philbrick, C. E., and Ernest W. Bowditch, sanitary en-

gineer, of Boston, into the conditions under which different styles of traps lose their water seal by siphon action.

As a result of the carefully conducted experiments of these competent professional experts, it appears probable that the ordinary S trap alone, with ample air-vent, is the best for use under water-closets, and also for all other fixtures where its proper ventilation can be secured within reasonable limits of expense. The proper length and size of such vent pipes must be largely a matter of judgment. Their combinations admit of such a great diversity of conditions that the engineers who conducted the experiments urge that every one should be severely tested by repeated trials, applying larger vents or making the small sizes shorter whenever any doubt arises as to their efficiency. They found that the best and most simple remedy for the siphoning of traps, in most cases, was the introduction of air at the normal pressure at the crown of the trap. In this position of the vent it was observed that the water dashed up into the vent-pipe, and when it receded a portion of this water dropped back into the trap, and just sufficed to keep its seal where the vent was three inches in diameter, but not when smaller. The loss of the water was plainly attributable to the momentum of the stream when passing through the trap quite as much as to the air draft. This valuable report will be found in Appendix B.

III. An investigation by Mr. Ernest W. Bowditch, sanitary engineer, of Boston, on the sanitary condition of summer resorts, which was mentioned in the last annual report as in progress, has now been completed. A thorough inspection of selected portions of Newport, Long Branch, and other places, which from the wide extent of country from which they derive their patronage assume a national character and importance, was made by Mr. Bowditch, whose report is appended, and marked C.

IV. The investigation, under the direction of Prof. J. W. Mallet, F. R. S., of the University of Virginia, with the co-operation of Prof. H. Newell Martin, D. Sc., M. A., M. B., of the Johns Hopkins University, Baltimore, on the best method of determining the amount of organic matter in potable water, and on the specific effects produced on the health of individuals who drink waters variously contaminated.

This investigation was referred to in the last (third) annual report of the Board as having been completed so far as the practical work of the laboratory was concerned, while the preparation of the report thereon had just begun. This report, which involved great labor and a considerable expenditure of time, was placed in the hands of the Board before the close of the fiscal year, but, owing to its length and the number of important accompanying plates and charts, it was found impracticable to publish it *in extenso* in a supplement to the Bulletin with the small remnant of the fund available for printing. An abstract, embodying the general conclusions deducible from the carefully conducted experiments, was prepared by the author at the request of the Board, and has been published in Supplement No. 19 of the Bulletin.

This abstract has already been republished in chemical journals of this country and of England, and has awakened a lively desire on the part of sanitarians in both countries for the publication of the full report. By the consent of all competent judges who have seen the abstract, Professor Mallet's paper is regarded as the most complete and valuable inquiry into the sanitary relations of potable water which has yet been made.

This inquiry involved the performance of a vast number of delicate experiments, conducted under his direction by the three chemists, Mr. W. A. Noyes, Dr. Charles Smart, U. S. A., and Dr. J. A. Tanner, U. S.

N., who took charge severally of the so-called "combustion process" of Frankland and Armstrong, the "albuminoid-ammonia process" of Wanklyn, and the "permanganate process" in the form advocated and minutely described by Tidy. These chemists worked independently, the first in the laboratory of the Johns Hopkins University, by permission of its authorities; the second at the office of the National Board of Health; and the third in the laboratory of the University of Virginia. Professor Martin, of the Johns Hopkins University, undertook a simultaneous microscopic examination of the waters, and also a series of pathological observations on the effect of injecting these waters, concentrated by evaporation at a very low temperature, beneath the skin of rabbits, whose temperature and general condition were compared with those of like animals not so treated.

Among other results fairly deducible from these various experiments the following may be cited:

1. Clear proof that loss of organic matter does occur during the evaporation of a water prior to combustion of the residue by Frankland's method, contrary to what has always been claimed by Frankland.

2. Evidence of a source of serious error in the determination of nitrogen by the same process, there being a notable gain of nitrogen from the atmosphere.

3. Much fuller information than has hitherto been obtained as to the extent to which definite substances belonging to various chemical classes, and including some of the known products of putrefaction, are attacked by potassium permanganate in acid and in alkaline solution.

4. An extended comparison of the practical results of the Frankland, Tidy, and Wanklyn processes, as applied to a series of waters from known sources, and of known sanitary (or insanitary) character also to waters artificially polluted with sundry forms of manufacturing refuse, and with forms of organic matter liable to be encountered in connection with ordinary water supply.

5. Proof of the error of the statement by Wanklyn that urea is not decomposed by treatment with alkaline permanganate in such a way as to yield so-called "albuminoid ammonia."

6. Results of the exhaustion or continued treatment of organic matter by the Wanklyn and Tidy methods.

7. Results of biological experiments (subcutaneous injection of rabbits) with waters examined simultaneously by chemical processes.

Among other results obtained in this connection it was observed that while "in many cases the waters which produced most decided effects upon the rabbits contained *very large* amounts of organic matter, so large as to probably invalidate a comparison with the natural waters or with much more dilute specimens of artificial preparation," yet, on the other hand, in several instances, on comparing the pathological results from three different strengths of a solution of the same organic material, it was found that it is not the strongest which has produced the most marked effects. This apparent anomaly lends support to the idea that it is not mainly the quantity of organic matter, but the presence and nature of low organisms which render drinking water unwholesome.

The results obtained as to the presence of nitrates and nitrites in waters received from various parts of the country, with medical testimony as to their having in all probability actually caused disease, strongly suggested the idea that these salts, instead of merely affording evidence of the *previous* contamination of the water with nitrogenous matter, as is generally assumed, may possibly afford proof of the presence of *noxious*

organisms in the shape of those now proved to be concerned in nitrification. Professor Mallet, in this connection, submits the inquiry:

> Is nitrogenous organic matter, when undergoing decay so as to produce nitrates, more or less noxious than the same kind and amount of such organic matter when decaying under conditions to produce ammonia? For if the dangerous character of nitrifying decay were established, a number of important practical conclusions would result; among others, a more prominent and better-founded importance should attach to the simple and accurate determinations of nitrates and nitrites in water analysis for sanitary purposes.

8. Results bearing on the commonly assumed difference between *animal* and *vegetable* sources of pollution in regard to the danger to health. It has been generally assumed that organic matter of vegetable origin is harmless, or comparatively so, while that of animal origin is highly dangerous. The results ascertained by Professor Mallet go to show that under the special conditions of these experiments with rabbits, vegetable matter representing mainly or largely alteration-products of woody fiber may be in a high degree pernicious. It was observed that for nearly all the waters classed as "dangerous" by Professor Martin and his assistant, Dr. Hartwell, the ratio of organic carbon to organic nitrogen was rather high. It was, however, also observed that in the well marked cases of such results the amount of organic matter in the water was large, and it would not be safe to affirm on this evidence alone that similar waters, if diluted to the ordinary potable standard, would still prove themselves capable of causing disease or death in the animals experimented on. Indeed, the evidence tends rather the other way.

A printed copy of the abstract, together with the MSS. of the full report, are hereto appended, marked D.

V. A supplementary investigation as to the value of certain improvements suggested in the foregoing report in the methods of water analysis has been carried out by Prof. J. W. Mallet, aided by Dr. Charles Smart, U. S. A.

The former of these chemists has ascertained that the results of the so-called "combustion process" of Frankland may be improved, and cleared of some at least of the inherent errors of the process as hitherto conducted, by evaporating the water in a partial vacuum, and the necessary details of apparatus suitable for the purpose have been worked out. It has been found that the suggested use of magnesia as the material for the expulsion of ammonia during the evaporation of the water is attended with loss of the nitrogen of certain classes of organic substances; while it appears that hypophosphorous acid, proposed as the means of reducing nitrates and nitrites, may be so employed with probably insignificant injury to the organic matter present.

Dr. Smart has examined certain proposed modifications of the "albuminoid ammonia," process, and has determined some points of practical interest concerning the evolution of ammonia from water at various temperatures and under diminished pressure, and its subsequent condensation by cold and absorption by acid. These papers also will be found in Appendix D.

VI. The investigations on the filtering capacity of soils commenced by Prof. Raphael Pumpelly, of the United States Geological Survey, assisted by Prof. George A. Smyth, and of which a preliminary report was printed in the Bulletin of the National Board of Health and communicated to Congress as an appendix to the Third Annual Report, have been suspended for want of the necessary funds for their continuance. This is a source of great regret, inasmuch as the investigations in question had proved to be of extraordinary value and importance. The preliminary report had awakened the liveliest interest among sanitarians all over the world, and one eminent scientist, who has made

many valuable contributions to the sanitary applications of chemistry, has pronounced it "to be one of the most important contributions ever made to our knowledge of the propagation of epidemic diseases." (Dr. Frankland, Normal School of Science, South Kensington Museum, London. Letter to Professor Pumpelly.) A report of the experiments made in continuation of these investigations from the rendition of the first report to the enforced suspension of the work is appended and marked O.

VII. An inquiry into the causes and nature of malaria, with special reference, to the conditions of its recent prevalence in the States of New York, Connecticut, Rhode Island, and Massachusetts, was commenced, with the approval and co-operation of the several State boards of health, who were to furnish the topographical and clinical data, while the scientific investigation of the essential nature of the malarial poison by experimental processes similar to those of Klebs, Tommasi-Crudeli, and Sternberg was assigned to Dr. J. D. Whitney, of Boston.

This investigation was regarded by this Board as likely to lead to very important results in their bearing upon the public health of an extensive region recently invaded by malarial fever. It was clearly such an investigation as was within the scope of the duties assigned to the Board by the act of March 3, 1879, and as relating to a subject in which the entire country is more or less interested, was one for which the service of a National Board of Health was eminently appropriate. It is deeply to be regretted, in the interests of the public health, that it has been necessarily abandoned for want of an appropriation applicable to such purposes.

COLLECTION OF VITAL STATISTICS.

It has been often and fitly said that "modern sanitary science owes its existence to the registration of deaths and their causes, and the localization thereby of insanitary conditions." By this means, properly applied, the sanitary authorities are also promptly informed of the existence of diseases, whose prevalence may be arrested by the prompt and efficient application of sanitary measures, thus permitting the realization of the most beneficent results in the saving of human lives and in averting losses of the productive energies of a people. These results are realized on a large scale under the admirable system of registration which is organized in Great Britain, in which country not only the registration of births, marriages, and deaths is made public in weekly, quarterly, and annual reports, but also the taking of the census is intrusted to the registering authorities.

In this country no attempt is made by the general government to collect vital statistics, except once in ten years in connection with the taking of the decennial census, and even for that one year in ten the results have been in the highest degree unsatisfactory and misleading. It is stated by General Walker, in the Report of the Census of 1870, that—

> At no one of the three censuses taken under the act of May 23, 1850, has the aggregate number of deaths returned by the assistant marshals risen above two-thirds of the number of deaths probably occurring during the year of enumeration as that number is deduced from the experience of other countries, from the experience of sections of our own country having an established system of registration, and from the ascertained law of national increase.

E. B. Elliott, esq., chief clerk of the Bureau of Statistics of the Treasury Department, makes these remarks in the same volume:

> The great deficiency manifest in the return of deaths, a deficiency inherent in any system which seeks to procure complete returns of these events for an entire year by simply conducting an inquiry at its close, will, for the future, it is earnestly hoped,

be remedied by legislation establishing a national system for the registration of deaths and of births as they occur. By no simpler or less radical process is it possible for the statistics of the movement of population of the United States to be placed on a par as to efficacy and completeness with that of England, France, Belgium, Prussia, Sweden, Norway, and certain other of the progressive states of Europe. Legislation by the several States of the Union is necessarily inadequate to the accomplishment of the object.

Adverting to some of the consequences of this defect, the distinguished Superintendent of the Census of 1870 made the pertinent remark that—

> The dimensions attained by the life-insurance interest within the past few years make it peculiarly a matter of regret at the present time that the census should not afford the data for determining with absolute precision and certainty the death-rate of the country, whether in the aggregate or by classes of the population. This [he added] can never be done without a national scheme of registration, stringently enforced by penalties. Such a scheme, however, does not exist, and is, perhaps, in the nature of our government, wholly impracticable.

Sanitarians at least would have been greatly surprised if in interpreting its duty under the provisions of the constituting act, "to obtain information upon all matters affecting the public health," the Board had not given early attention to the importance of devising and recommending some means for collecting and reporting the mortality statistics of the country according to a uniform plan of registration of deaths and their causes as they occur. The National Academy of Sciences, which had been required by the constituting act to confer with the Board, made a special recommendation on this subject to the effect that the—

> Board should take steps to secure, as far as possible, uniformity in the methods of collecting and reporting vital statistics; and that to this end it should call a convention of representatives of United States, State, and local authorities especially engaged in the collection and reporting of such statistics, with a view to securing agreement upon this subject.

Such a convention was accordingly invited by the Board, and was held in Washington May 6 and 7, 1880. After a full discussion of the questions offered for consideration, it was unanimously agreed—

> That whereas the methods of collecting vital statistics must necessarily vary in different States and localities, the determination of the nearest approach to uniformity and completeness which can be recommended for such purpose be referred to the National Board of Health.

In harmony with this decision, the committee appointed by the conference to consider the best method of tabulating mortality statistics made a report on this subject to the Board, which, together with a full report of the proceedings of the convention, has been noticed in the Second Annual Report of the Board for the year 1880.

More recently the standing committee of the Board on registration and vital statistics has made, through its chairman, Dr. J. S. Billings, a report of the various forms of legislation by which, in this country, attempts have been made to secure registration of vital statistics, with appended copies of all the various acts passed up to the present time, together with a brief historical sketch of the progress of registration in each State and the results obtained. There is also appended a table showing the results of an analysis of the various registration laws, so arranged that each can be readily compared with the others in regard to any particular item. This report will be found in appendix marked E.

It appears that of the twenty-three States which have had registration laws only eight have published statistics of any scientific value, the real cause of this failure being the want of sufficient compensation to the registering officers. One of the first things, therefore, to be con-

sidered in devising any scheme for the registration of vital statistics is the cost. After adverting to the actual cost of such registration in Massachusetts, which has the most complete system of any of the States of the Union, the reporter concludes that it is theoretically possible for the United States to secure as complete a registration of births, marriages, and deaths as is done in any country by the very simple process of paying all the expenses, but that this plan seems impracticable by reason of its enormous cost. Nor does it seem necessary or even desirable that the general government should be in possession of all the details of registration to be obtained at such an expense. The results needed by the United States may be had from the State registering authorities, who may be stimulated to furnish reports of a sufficient degree of completeness and accuracy to fit them for sanitary and statistical uses by the general government agreeing to pay a part of the expense of collecting them. It is estimated that at the present time the general government would probably not be called upon to pay for more than 10,000,000 of the population, or about $25,000 per annum; certainly not an unreasonable amount to secure the great advantages to be derived from the collection of such important data. The Board accordingly considers it very desirable that Congress should, by special act, authorize the aiding in the collection of vital statistics in the manner indicated in the report of the committee, and appropriate the amount necessary to give its action practical effect.

OPERATIONS OF THE BOARD WITH RESPECT TO QUARANTINE, MARITIME, AND INTERSTATE.

MARITIME QUARANTINE.

The attention of sanitarians and statesmen had for a number of years been directed to the fact that while certain ports of the United States had a more or less effective system of maritime quarantine, a very much larger number were destitute of such means of preventing the introduction of contagious or infectious diseases, and thus that such diseases might, and often did, find access through these unguarded portals and place in jeopardy the health and lives of other communities having direct or indirect commercial intercourse with the ports thus invaded. It is sufficient to allude to the interesting and valuable discussions in the several national quarantine and sanitary conventions, of which the fourth and last, held in the city of Boston June 14–16, 1860, was composed of delegates from nearly all the seaboard and Mississippi Valley States, to indicate the growing interest on this subject and the instinctive desire for more uniform and more complete quarantine regulations for the adequate protection of the country against the introduction of infectious diseases of exotic origin. The advent of the war between the States interrupted the further progress of such influences as were incident to the operations of these voluntary associations, and, as might have been expected, men's minds were, for some years after the close of the war, too much engrossed with the tremendous issues of that unhappy strife to permit them to renew these investigations.

But in the session of Congress of 1871–'72 the subject engaged the attention of that body, and the following "Joint resolution providing for a more effective system of quarantine on the Southern and Gulf coasts" was passed, and was approved by the President June 6, 1872:

> Whereas experience has proved that the present system of quarantine on the Southern and Gulf coasts is inefficient to prevent the ravages of yellow fever in the cities and towns of that section: Therefore,

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and is hereby, directed to detail one or more medical officers of the Regular Army, who shall, during the coming season, visit each town or port on the Gulf of Mexico and the Atlantic coast which is subject or liable to invasions of yellow fever, and shall confer with the authorities of such port or town with reference to the establishment of a more uniform and effective system of quarantine, and who shall ascertain all facts having reference to the outbreak of this disease in such ports or towns, and whether any system of quarantine is likely to be effective in preventing invasions of yellow fever, and if so, what system will least interfere with the interests of commerce at said ports; and shall make also a detailed report on this subject to the Secretary of War, through the Surgeon-General, on or before the assembling of the third session of the Forty-second Congress in December, 1872.

Assistant-Surgeon Harvey E. Brown, on the recommendation of the Surgeon-General, was detailed by order of the Secretary of War, under Special Orders No. 139, Adjutant General's Office, June 17, 1872, to make the inspections and reports required under the said joint resolution of Congress, and on the 6th of December the Secretary of War transmitted to the Senate and House of Representatives the full report of Dr. Brown, which, on the 9th of that month, was referred to the Committee on Commerce and ordered to be printed.

The result of Dr. Brown's inspections was such as to convince him—

1st. That in the vast majority of epidemics, if not all, that have occurred in the United States, the germinal principle of the disease was imported from elsewhere, and was not due to local causes.

2d. That a system of quarantine can be organized which will prove effective in preventing invasions of yellow fever.

3d. That a properly organized system, so far from interfering with the interests of commerce, will prove really beneficial to the commercial prosperity of ports where established.

4th. That the present quarantines at the South, being established by either State or municipal authority, lack that uniformity which is absolutely necessary to their efficiency, are not founded on rational views of the pathology of the disease, and are generally defective in their administration; and that, consequently, a system of a different character must be adopted to attain the end desired.

5th. That yellow fever needs to be planted in a favorable soil in order to become epidemic, and that, consequently, the danger from the disease is measurably lessened in proportion as attention is paid to the local hygiene and sanitary condition of those parts of the ports or towns which, by reason of the character of the inhabitants or other causes, are usually the habitation of the earlier cases.

At the date at which this report was made the first four of the above propositions, though accepted by a majority of experts, met with some opposition on the part of a minority highly respectable in personal character and in professional standing. Later observations and experience have had the effect of producing an almost entire concurrence among sanitarians in Southern cities in the truth of the four propositions in question. Indeed, it is impossible to consider with care the well authenticated facts collected by Dr. Brown without being constrained to adopt his conclusions, which were also announced by the health authorities of most of the Southern ports. Especially was there a general concurrence in the opinion that the quarantines under the actual State and municipal regulations—

Were not to be depended upon to accomplish the desired end, and that only under the direction and control of the general government can any reasonable degree of protection be afforded, conjoined with such competency of administration as will afford the largest liberty to the interests of trade, consistent with public safety.

The board of health of the city of Pensacola states:

"This board does earnestly solicit that Congress may take such further action upon the subject as shall place the whole matter of quarantine under the exclusive jurisdiction and control of the authorities of the United States."

Dr. Jerome Cochran, health officer of the city of Mobile, writes:

"I am thoroughly satisfied that a quarantine under the control of the general government would be far more efficient than any other plan that can be adopted. We

need a complete sanitary cordon all along the Atlantic coast, and especially all along the coast of the Gulf of Mexico, and this will be very difficult under the action of the various State and municipal governments. The fever poison follows the lines of commercial intercourse, *and the power which regulates commerce should be extended also to the regulation of quarantines.*" (Letter, September 28, 1872.)

Prof. J. T. Gilmore, of Mobile, writes:

"Believing that the yellow fever can be imported, I, of course, am an advocate of efficient quarantine, and I am satisfied that this cannot be done except by the Federal Government. Local and private interests always so vitiate the efficiency of a local quarantine that it is rendered useless." (Letter September 10, 1872.)

Mr. J. H. Oglesby, president of the New Orleans Chamber of Commerce, is of opinion that "the laws imposing quarantine against foreign infected ports ought to be uniform throughout the United States. In giving expression to this opinion it is not necessary to discuss the extent of power legally to be exercised by the Federal Government. It is sufficient to know that the power to regulate commerce enables Congress to impose a uniform tax on all commodities imported, and so prevent one city from intercepting the commerce of another by an offer of more favorable duties on such imports. The effects of the quarantine system, as adopted by the several States, enables one city to cut off all communication with another, except under certain conditions fatal to the trade. Congress should, therefore, organize an appropriate bureau of public health. * * * The health authorities at all such American ports should be appointed or approved by the bureau of public health. The salaries of all such officers and employés so appointed, with all other expenses properly attending the enforcement of the law, should be paid out of the Federal Treasury, and in no other manner. * * * The Federal Government can better preserve the general health and *protect the general commerce* than can be done by the competitions or even combinations of rival cities."

Many assurances [continues Dr. Brown] of a similar character were given to me in conversation with persons, both professional and otherwise, in every city visited. It is true that some made the objection that it would be adding to a supposed tendency to centralization on the part of the general government; but even these acknowledged that, apart from this political consideration, the quarantine would be more efficiently and at the same time leniently conducted under national auspices than at present.

An extensive yellow-fever epidemic occurring in the next summer (1873) induced Representative Bromberg, of Alabama, to introduce a bill for a national quarantine, which was framed in conformity with the recommendation of Dr. Brown, and which passed the House but failed in the Senate, apparently because of the objections urged by Senator Thurman, that a conflict of jurisdiction might arise between the Federal officers and those of the States, since the competency of the latter to enact health regulations and enforce them by their police powers had been settled by a favorable decision of the Supreme Court.

In April, 1878, a bill was passed conferring certain quarantine powers on the Supervising Surgeon-General of the Marine Hospital Service, but no appropriation was made to enable him to carry out its objects and the law became inoperative.

The quickly-following epidemic of that year which proved so destructive to life, and which is estimated to have cost the country some $200,000,000, gave a new impulse to the movement for an attempt to avert such gigantic disasters in the future by means of quarantines to prevent the introduction of the infectious material. At the annual meeting of the American Public Health Association in Richmond, in November of that year, a meeting attended by the health authorities of all the Southern cities which had so recently suffered from the invasions of the fever, and also by the leading sanitarians of the North, the following resolutions were adopted:

3. That it is the duty of the general government to aid in the establishment of a practical and proper quarantine by all means in its power.

* * * * * * *

5. That it is the duty of the general government to invite foreign nations to cooperate with it in the establishment of uniform and effective international quarantine regulations.

On the assembling of Congress each branch appointed a special committee to "investigate and report the best means of preventing the introduction and spread of epidemic diseases," and on their recommendation a mixed Congressional and medical commission was created by act of Congress, for the purpose of collecting the opinions of physicians and others resident in the localities where the fever had prevailed as to the causes of the outbreak and the most practicable methods of averting a recurrence of such disasters in the future.

This commission, following immediately on one which had been organized by Dr. J. M. Woodworth, at the request of Mrs. Elizabeth Thompson, who paid all its expenses, reached similar conclusions as to the exotic origin of yellow fever and the necessity of a rigid quarantine for its exclusion from the country. The report states that the object aimed at was—

> To present the outlines of a system of quarantine which may afford the greatest attainable degree of protection against the introduction and spread of infectious epidemic diseases; and at the same time inflict only a minimum of injury and inconvenience on commerce. Two classes of medical officers are suggested: First, medical officers of health to serve in foreign ports from which we receive importations of yellow fever and cholera. Secondly, medical officers of health to have charge of quarantine stations, and to supervise inter-State travel and traffic from infected places in times of epidemic. The two classes of medical officers suggested are considered indispensable to any methed of quarantine which does not involve complete suspension of intercourse with infected ports.
>
> The board is unanimous in the opinion that the investigation of the late epidemic should be completed, and that the study of the natural history of yellow fever should be systematically pursued, and especially that the inquiries should embrace the perpetually infected ports of the West Indies, there to make a more thorough study of yellow fever than has yet ever been undertaken, and that they be accompanied by an experienced microscopist. It is further recommended that the necessary steps be taken by Congress to secure the co-operation of other foreign governments, through an international commission, or otherwise, in an earnest effort to ascertain the cause, or causes, which perpetuate the yellow fever from year to year in the West India islands, and to devise ways to remove the cause or causes, or to lessen the chances of transporting the poison to the United States or other countries.

It will be seen in the sequel that the National Board of Health adopted this last suggestion of the Congressional commission of experts, which, in this and in some other respects, foreshadowed the action of the Board.

In its views concerning quarantine, the commission voiced the opinions of most of the medical experts whose testimony was taken. Thus Dr. Joseph Jones, then a member of the board of health of the State of Louisiana, in giving his sworn evidence before the Congressional committees, is reported in the Times of January 4, 1879, as saying:

> I think that a national quarantine system, carefully and honestly administered, would be efficient in preserving the safety of ports on the Gulf coast. If this city was guarded with an efficient system of quarantine, and that of the neighboring cities, say Mobile and Galveston, was lax and careless, there could be no protection unless this city was quarantined against those places.
>
> I favor a quarantine system which, at certain times, will shut off intercourse with South America and all ports of the Antilles. If the harbor at Ship Island is land-locked, it would be *very beneficial* to have a quarantine station at that point. * * * I think that a station at Ship Island would be a *good measure*, provided all the bayous and inlets were guarded.

The Picayune reported Dr. Jones as testifying:

> I think a *national system of quarantine*, extending from New York to Galveston and honestly conducted, would, in a majority of cases, prevent the introduction [of yellow fever] in those cities.

On the return of the mixed commission to Washington, where the general report of the medical experts was prepared and submitted, the Senate Committee recommended the establishment of a bureau of

health, with a director-general of health as its chief executive officer, and president of a board of health, to be composed of seven members appointed by the President with the advice and consent of the Senate, and also of the Surgeon-General of the Army and the Surgeon-General of the Navy as *ex officio* members. This board was to be charged with the making, subject to the approval of the President of the United States, such uniform quarantine rules and regulations as may be necessary and authorized by law and with the execution of the same. It was also charged with the supervision of all matters connected with the Marine-Hospital Service; the office of Supervising Surgeon-General of that service being abolished by one of the provisions of the bill.

It was urged by the committee that, while Congress has no power to interfere with any quarantine regulations made by any State and enforced within its borders, it has an indubitable right to so regulate commerce as to prevent the importation of contagious diseases from foreign countries and from one State into another. The bill further invited the State and local authorities to undertake the execution of its provisions, and only in the case of refusal or failure on the part of the local authority to do this was the Secretary of the Treasury to appoint a health officer of the United States for such port to carry out such rules.

This bill and some others, more or less similar in their main features, were far less objectionable than one which had been introduced in the early part of the session before the publication of the report of the commission, and which, in respect of quarantine, conferred an authority untrammeled by any deliberative or advisory board upon a single officer, to be called Director-General of Health.

Nevertheless, the bill of the committee did not meet with general favor, for while it passed the Senate, it was defeated in the House of Representatives. And although an act creating the National Board of Health was carried through both houses in the last hours of the session and immediately approved by the President March 3, 1879, it conferred no power and imposed no duty in respect of quarantine.

Early in the extra session a new bill was introduced in the Senate by Senator Harris, of Tennessee, which conferred upon the newly created Board of Health quarantine powers to be exerted at stations lying outside of the jurisdiction of the States; but even in this modified form earnest and successful opposition was made by the leading representatives of the great commercial interests of the country.

The bill was recommitted, and it was not until the objectionable feature which had conferred police powers upon the Board had been entirely dropped that Congress was induced to enact a bill to authorize the Board to co-operate with, and, as far as it lawfully may, to aid State and local boards in the execution and enforcement of the rules and regulations made by such boards to prevent the introduction of infectious diseases into the United States and from one State into another. This act, approved June 2, 1879, is entitled "An act to prevent the introduction of contagious and infectious diseases into the United States." This title is the keynote to its provisions, which all look to the prevention of the importation of infectious diseases into the United States from foreign countries and from one State into another. In other words, it is a quarantine law, imposing additional duties upon the National Board of Health, but conferring no police powers whatever.

In this act the attempt had been successfully made to conciliate two classes of the opponents of other proposed bills, namely, those who deprecated the apparent tendency to centralization and absorption of State authority, and those who were apprehensive that the commercial inter-

ests of the principal ports of entry would be seriously disturbed by confiding any quarantine power to a central authority not amenable to the influence and control of a local constituency. Instead of assigning quarantine duty directly to the Board, the act of June 2, 1879, only authorized the National Board of Health—

> To co-operate with, and, as far as it lawfully may, to aid State and municipal boards of health in the execution and enforcement of the rules and regulations of such boards to prevent the introduction of contagious and infectious diseases into the United States from foreign countries and into one State from another.

It is true that it also made provision for the protection of the public health in case the local authorities would refuse or fail to enforce adequate rules, but the discretionary authority in such a contingency was conferred upon the President of the United States and not upon the Board of Health, whose only duty in such case was to notify to the President the danger likely to arise from the dereliction of the local officers of health.

Prior to the enactment of the law of June 2, 1879, the Board of Health, by virtue of the authority conferred by the constituting act of March 3 of the same year, and in accordance with the above-cited earnest recommendation of the Congressional commission, had organized a scientific and sanitary commission for the study of yellow fever in Havana and other ports of Cuba where the disease is permanently established. The extremely valuable preliminary and final reports of that commission have heretofore been transmitted to Congress and ordered to be printed in connection with the first and second annual reports of the Board. The subject is now simply referred to as indicating the desire and the aim of the Board to conform to a plan of operations which had apparently received the unanimous sanction of a joint committee of the two Houses of Congress.

Its duty under the provisions of the third section of the act of June 2, 1879, as cited above, was not of easy execution. A demand was made from more than one quarter for a *pro rata* distribution of the $500,000 appropriated by that act. It was apparent enough that in rendering aid to local boards under the provisions of the act in question the National Board was bound to see that the aid was given in such a way as to be really available for the execution and enforcement of rules and regulations adequate to the prevention of the introduction of contagious or infectious diseases into the country; and by the express terms of the act it was required that the disbursements of the Board should be subject to the supervision and direction of the Secretary of the Treasury. Funds could not, therefore, be turned over to the local authorities to be used at their discretion, but the latter were to present vouchers duly certified by the parties rendering service or furnishing goods, when authorized by the Board, and payment to be made in checks payable to the order of such parties. It became necessary, therefore, that the Board should be satified of the fitness and adequacy of the rules and regulations of the local boards to secure the ends of the law, before it would be warranted in expending the public money to aid in their execution and enforcement. Accordingly, the Board prepared a body of rules and regulations, *recommended* to be adopted and observed at all ports in the United States which are or may be designated as quarantine stations, having been aided in their preparation by the quarantine officers of the principal ports of the United States, all having been requested to participate. They were prepared with care and deliberation, and were promptly adopted by the health authorities of nearly every port of the United States.

At or near the same time the following rules and regulations, authorized to be made under the provisions of the law, were made and published:

1. Rules and regulations for securing the best sanitary condition of vessels, including their cargoes, passengers and crews, coming to the United States from any foreign port where any contagious or infectious disease exists. These rules and regulations, when approved by the President, have the force of law, and were to be communicated to and enforced by the consular officers of the United Sttes, subject to certain conditions.

2. Rules and regulations *recommended* to be adopted and observed for securing the best sanitary condition of steamboats and other vessels, including their cargoes, passengers and crews, going from any port in the United States where yellow fever exists to any other port or ports in the United States.

3. Rules and regulations recommended to be observed at the port or place of departure when yellow fever exists there or in the vicinity.

4. Rules and regulations recommended to be adopted and observed for securing the best sanitary condition of railroads, including station houses, road beds, cars of all descriptions, freights, passengers, and employés, coming from any point where yellow fever exists; and also those to be observed and enforced at any place where yellow fever exists, having railroad connections with other places.

5. Rules and regulations recommended to be adopted and observed when yellow fever is reported or suspected to exist in any town or place in the United States.

6. Circular to State and municipal health authorities, transmitting the foregoing rules and regulations, which the Board *recommended* to be adopted in order to secure efficient co-operation, by means of measures as nearly uniforrm as possible, in the important work of preventing the introduction of contagious and infectious diseases into the United States and into one State from another.

These several papers were transmitted to Congress in connection with the First Annual Report of the Board and have been printed in Appendix N of that report. Some of them, notably the first in the above series, have recently been modified to some extent in order to adapt them to the special treatment of the actual or threatened introduction of small-pox into the United States, and the railroad transportation of immigrants landing on our shores from countries in which that disease exists.

One of the first steps taken by the Board after the passage of the act of June 2 was to make a rapid sanitary survey of the various maritime ports of the United States from Portland, Me., to the mouth of the Rio Grande, with a view to ascertain what might be necessary to give efficiency to their quarantine machinery and security to the country against the introduction of infections of exotic origin. Dr. Brown, in his report on "Quarantine on the Southern and Gulf Coasts" had called the attention of Congress to the fact that—

> At many ports that have but little commerce there is at present either no quarantine or only a nominal one, because the revenue from fees is not sufficient to defray the expenses of its management. This would be obviated under a general system by the transfer of the surplus accruing at the larger cities to pay such deficiencies. Many of these unimportant ports, especially those situated near the Mexican frontier, carry on a trade in small vessels which, being seldom cleansed or repaired, become more dangerous as transports of the germinal principle of the disease than the regular traders to the larger seaports. *One of these craft introduced the fever into Indianola, Tex., in 1867, whence, as we have seen, it extended over a large portion of the southern country.*

The information acquired by the Board, through the reports of the inspectors appointed to visit all these ports, was exceedingly valuable and in fact absolutely essential to a clear comprehension of its duties in the premises. These reports were also transmitted to Congress and published in connection with the First Annual Report of the Board. They revealed to the knowledge of the Board a work to be accomplished, the magnitude of which seemed at first view well nigh appalling. An effective quarantine requires the following elements of equipment: (1) A steam boarding vessel and boats with officers and crew, to be ready at all times to convey the quarantine inspecting officer to the quarantine anchorage where suspected vessels are detained until released by order of the said officer; (2) a hospital in which persons sick with infectious diseases may be isolated and treated by a competent physician; (3) a lazaretto for the accommodation of persons not sick but detained under observation as having been taken from an infected vessel; (4) officers' quarters; (5) a warehouse of sufficient dimensions to store the cargoes of infected vessels when it becomes necessary to discharge the cargo in order to its disinfection and to the cleansing and disinfection of the hold of the vessel; (6) a wharf or wharves at which the discharge of cargo takes place; (7) boats, &c., or for administration.

The law made it the duty of the Board to aid State and municipal boards of health in their efforts to prevent the introduction of infection through any avenue by which it was likely to find entrance into the country. It was just as easy to find admission through the smaller and unimportant ports, and thence to spread through the country, as through the ports of larger trade, protected, as the latter are, by a more perfect quarantine machinery, kept in constant operation by means of abundant quarantine fees. Numerous examples might be cited besides that of Indianola, in 1867, and there are several dozen of such ports whose insignificant trade does not warrant the expectation that the local authorities will go to the expense of providing the necessary safeguard against the introduction of yellow fever, and yet the character of that trade carried on in foul vessels exposes them, in a special degree, to the risk of receiving the infection. What was the National Board of Health to do to meet the requirements of such cases? Was it to wait until the infection had been introduced and then only interfere by establishing a cordon around the infected territory? The act of June 2, 1879, may be scrutinized in vain to find a warrant for such a course of official action. The object of the law was, in the first instance, to prevent the introduction of infection into the United States, which is far more easily accomplished by appropriate means than it is to circumscribe it within narrow limits after its introduction. At all events, such was the expressed object of the law, and the duties of the Board were so defined as to be clearly in conformity with this object. But it was manifestly out of the question to attempt to establish a thoroughly-equipped quarantine station at each of the numerous exposed ports not protected by State or municipal regulations adequately enforced. An attempt to do this would have required more than ten times the full amount placed at the disposal of the Board. In this dilemma, the Board profited by the experience of other nations having a longer and larger experience in matters of quarantine. Thus, in France and Portugal, vessels subject to quarantine which arrive at ports where quarantine cannot be undergone must proceed immediately to quarantine stations; as, for example, vessels liable to quarantine at Dieppe and other northern ports of France are sent to the quarantine station

at Havre, and medical assistance is provided at the public cost. (Sir Sherston Baker: Laws relating to quarantine, 1879.)

But the English law was yet more suggestive and significant. By virtue of an act of Parliament, orders in council provide that all vessels not having infectious disease actually on board, but not furnished with clean bills of health, arriving in the United Kingdom, and coming from the Mediterranean or from West Barbary on the Atlantic Ocean, shall perform quarantine in Standgate Creek or Milford Haven, and nowhere else. Then, for actually infected vessels it is provided in the same orders in council as follows:

> 28. And for the better guarding against the introduction of the plague into the United Kingdom, it is hereby ordered that, in the event of the plague actually appearing on board any vessel on her voyage to any port in the United Kingdom, she shall immediately, if to the south of Cape St. Vincent, repair to some lazaretto in the Mediterranean, there to perform quarantine, and if to the northward of Cape St. Vincent, she shall immediately repair to Milford Haven, there to perform quarantine. (*Ibid.*, p. 91.)

Here, then, was pointed out a practicable method of executing the duties prescribed in the law of June 2, 1879, to the end of preventing the introduction of infectious disease into the United States at a comparatively trifling expense. It was only necessary to provide three or four refuge stations where good anchorage could be had at such a distance from the channels used by vessels engaged in trade as to insure perfect isolation, and thus avoid the risk of infecting other vessels. To such stations the local health authorities charged with the duty of exercising the police power of the States were to be invited to send all infected vessels liable to quarantine at their respective ports. It was ascertained that such a station could be established for about $30,000. It was proposed that each should be operated in aid of numerous ports distributed over an extensive line of coast and belonging to different States.

On consultation with its legal advisers it was ascertained that the act of June 2, 1879, did not confer authority on the Board to erect buildings or to acquire, on behalf of the United States, titles to real estate. When this fact was made known to the committees of the Senate and House of Representatives, which had been instrumental in procuring the enactment of the law in question, a supplemental bill was introduced, and having passed both houses was approved July 1, 1879. By the sixth section of this act it is provided that—

> Section 3 of the act approved June 2, 1879, entitled "An act to prevent the introduction of contagious or infectious diseases within the United States," be amended as follows: At the end thereof insert: And the Board of Health shall have power, when they may deem it necessary, with the consent and approval of the Secretary of the Treasury, as a means of preventing the importation of contagious or infectious diseases into the United States, or into one State from another, *to erect temporary quarantine buildings and to acquire, on behalf of the United States, titles to real estate for that purpose*, or to rent houses, if there be any suitable, at such points and places as are named in such section.

In strict conformity with the provisions of this act, having the consent and approval of the Secretary of the Treasury, the Board proceeded to erect on Ship Island, with the consent of the Secretary of War, whose department held possession of the island, temporary quarantine buildings—temporary in the sense of being constructed of plank at small cost and yet commodious and capable of being kept in repair by a small annual outlay. The entire cost of four such buildings and a wharf of considerable length did not exceed $20,000.

Before it was practicable to erect corresponding structures at two other desirable stations, namely, at Sapelo Sound, on the Georgia coast,

and in Hampton Roads, the period had arrived for transmitting to Congress the First Annual Report of the Board, in which these facts were stated and a desire expressed that one or more such stations should be provided for the extended Texan coast, so critically exposed to invasion of yellow fever, from the nature of the trade carried on at the ports on that coast. The estimates of the Board for these projected works were not approved by the Committee on Appropriations, and at the next meeting of Congress, after the lapse of another fiscal year, the committee introduced into the sundry civil appropriation bill a clause prohibiting the use, by the Board, of any portion of the fund originally placed at its disposal, except the small amount designated in thebill, although there still remained to the credit of the Board, on the books of the Treasury, the amount of $324,000.

The necessary consequence of this action of the Committee, sustained by the House, has been a total want of protection of the ports of Texas west of Galveston, and a most defective machinery at Sapelo Sound and in Hampton Roads, as has been explained in former annual reports of this Board.

The New York quarantine serves for the protection not only of that city, but for the ports of New Jersey and Connecticut. And the quarantine authorities of Boston have signified their willingness to afford the same refuge for vessels liable to quarantine and bound to other New England ports. The extensive quarantines of these two great municipalities are thus virtually performing the functions of national quarantines.

With regard to the refuge stations provided by this Board, it should be observed that the Board has always disclaimed the least authority to compel vessels, even though infected, to resort to them. The term *national quarantine stations*, which has been applied to them, has sometimes led to the opinion that quarantine powers were exercised by the National Board, while the law only authorized it to co-operate with and, as far as it lawfully may, to aid State and local boards in the execution and enforcement of their quarantine rules and regulations. The local authorities, in the exercise of the police power reserved by the States, compel infected vessels to report to these stations. And this is done at every port on the South Atlantic and Gulf coasts, excepting only Key West and New Orleans.

The attention of Congress was invited in the Second Annual Report for 1880 to the exceptional position of Key West, and to the statements contained in the reports of Dr. W. H. Elliott and Dr. Jerome Cochran, as published in the First Annual Report of the Board, pp. 361–366 and 391–400. In view of the positive statements of both these gentlemen as to the utter hopelessness of the establishment of any system of quarantine inspections at that port, and of the fact that two officers of the Marine Hospital Service had contracted the disease there and died, one of them having incurred the displeasure and abuse of the town authorities for having officially reported the existence of the fever in the town, the Board instructed its secretary to warn the authorities of other ports, by means of the following circular letter. It had previously received a communication from Dr. D. M. Burgess, fully confirming the statement of Drs. Cochran and Elliott:

NATIONAL BOARD OF HEALTH,
Washington, D. C., June 29, 1882.

SIR: I am directed by the National Board of Health to inform you that it is of opinion, from the facts presented concerning Key West, that special danger exists from the introduction of yellow fever through that port; that it is in close communication with Havana, and there is no satisfactory evidence that the authorities of that port have

taken any proper sanitary measures or precautions looking to the prevention of the introduction of contagious or infectious diseases, more especially of yellow fever, into that port; that previous experience warrants the Board in stating that trustworthy information cannot be obtained as to the existence of yellow fever in that locality, and that this Board deems it proper to present this circular letter as a warning to all ports having communication with Key West.

Very respectfully,

T. J. TURNER,
Secretary National Board of Health.

The board of health of the State of Louisiana has persistently refused to send infected vessels bound for New Orleans to Ship Island. The health authorities of the Mississippi Valley States have with equal persistency demanded, in the interests of the public health of the valley, that no infected vessels should be allowed to pass Eadsport northwise. This demand was regarded by this Board as being reasonable. The fears entertained as to the probability of the introduction of yellow fever into the country in the neighborhood of the Mississippi quarantine from infected vessels detained there for treatment are believed to be warranted by past and recent experience. Entertaining this opinion the Board directed its presiding officer to address a communication to the governor of Louisiana, calling his attention to the importance of this measure of prevention, and respectfully advising him to use his influence to secure the needful legislation in furtherance of the end so earnestly desired by the States of the Mississippi Valley. This request of the Board, made in behalf of the health authorities of cities and States on the Mississippi River, was communicated by his excellency Governor McEnery to the legislature of Louisiana, but it does not appear that any action was taken thereon. The correspondence with his excellency will be found in appendix marked F.

For details of the operations of the Ship Island and Sapelo Sound stations during the past season reference is respectfully made to the reports of Dr. T. S. Scales and Dr. W. H. Elliott in appendices marked, respectively, G and H.

During the service at Ship Island station a case occurred where yellow fever reappeared in a vessel which had been fever free for fifteen days and fumigated in the interval. The Russian bark Iris arrived from Pensacola, Fla., on June 30. One of the crew died of yellow fever on the previous day. None of the others, fourteen in number, were sick, although the captain was the only one who had the protection given by a previous attack. On July 5 a sailor from this vessel was taken to hospital with yellow fever. He recovered and on the 15th was returned to his ship, which was fumigated, and as no other cases had developed in the mean time the vessel was discharged from Ship Island to report to the quarantine physician at Pensacola station, where she arrived on the 18th, on which day one man was taken sick and two or three others thereafter in rapid succession.

The vessel returned to Ship Island where, with one exception, all the others liable to the disease became affected.

It has been suggested that the Iris was the means by which the yellow fever was introduced into Pensacola, but Dr. Scales disproves the idea by showing that, first, this vessel did not go to Pensacola, but to its quarantine station; and, second, that there was no communication between the Iris and the Saleta or any other vessel during the short period of her stay there by which the fever could have been conveyed indirectly from her to the city. In this connection he makes an important statement which suggests the ballast of the Saleta as the means by which the importation of the fever was effected; but this question of the origin of the disease in Pensacola is under investigation at the pres-

ent time, and will be thoroughly discussed when all the facts have been obtained.

A hospital barge provided for the accommodation of persons in quarantine and sick with infectious disease was moderately equipped and loaned to the quarantine authorities of the Elizabeth River quarantine district, who habitually take care of the sick on vessels liable to quarantine, not only when such vessels are bound for the ports of Elizabeth and James River, but when they put into the roads under stress of weather or of infectious disease, or for any cause.

The experience of nearly four years has satisfied the Board that it is neither necessary nor desirable to clothe the central authority with quarantine powers in order to obtain a reasonable security against the invasion of foreign epidemics; that the argument so often triumphantly insisted upon, that it is only by means of a national quarantine that uniformity as to the regulations can be secured, is in point of fact specious and deceptive; and that the public health may be as efficiently protected under the system of co-operation with State and municipal boards of health inaugurated by this Board in conformity with the provisions of the act of June 2, 1879, as under any national system of quarantine which supersedes or interferes with State authority. Such a substitution of Federal for State authority seems undesirable for the following reasons:

1. It is doubtful whether the exercise of the authority to regulate quarantine would not be in conflict with a decision of the Supreme Court in the case of Gibbons *v.* Ogden.

2. If it be admitted that the power exists, its exercise would be impolitic in view of the universal and strenuous opposition of the commercial emporiums of the country, especially on the seaboard.

3. Any such assumption and exercise of power by the general government would involve the necessity of absolutely uniform regulations for all the ports of the United States, since the Constitution requires that "no preference shall be given by any regulation of commerce or revenue to the ports of one State over those of another." Now, such a uniformity as to details of sanitary regulations is not practicable nor desirable for ports so differently situated as to climatic influences and as to proximity to foreign centers of infection as are the various ports of an extended seacoast.

4. Such a system would almost certainly lead to the establishment of an enormously extensive bureau, with no better results in respect of the protection of the public health than will be realized under the system of co-operation with State and municipal boards of health when the latter system shall have been fully carried out by the establishment of a few more refuge stations, which can be effected at a very moderate outlay for construction and equipment and a trifling cost for annual maintenance.

The details of this system are lucidly explained in a paper by Dr. Stephen Smith, a member of this Board, on "The Maritime Sanitary Service of the United States, and the Relations of National and State Authorities." See Appendix I.

INTERNATIONAL QUARANTINE INSPECTIONS.

Dr. Harvey E. Brown, in his "Report on Quarantine on the Southern and Gulf Coasts," which has been repeatedly referred to in the foregoing pages, made the following important suggestion:

It would obviate to a great extent the necessity for detaining vessels on their arrival if precautionary measures were adopted at their port of departure and during the

voyage to insure their being kept in good sanitary condition. Arrangements should be made by international treaty with all friendly powers to insure that the giving of bills of health should not be, as it is now, a mere matter of form, by requiring that all vessels shall be refused clearance until the masters thereof present a certificate from the American consul or commercial agent that they have been inspected by a competent physician and pronounced clean, and that the passengers and crew are in good health on the day of embarkation. * * * The importance of obtaining accurate information of the condition of health in the West Indies and Mexico during the yellow-fever season has already been alluded to. Beyond a few chance inquiries made to masters of vessels, the Southern health officers take no pains to gain information on this point; but if they did, it is unlikely that, as merely the officials of a State or a municipality, their request, if made to foreign authorities, would meet with the attention the importance of the subject would demand. This information, however, could always be obtained from our consuls abroad, through the State Department, were the government to assume the care of the public health. The accuracy of the bulletins furnished by the Signal Bureau of the War Department has been found of the greatest service to commerce. A similar system, giving information each week of the health of every port having commercial transactions with the United States, would be of vast importance, and equally beneficial both in its effect on commercial interests and public health.

By reference to parts of sections 3 and 4 of the act of June 2, 1879, it will be seen that this suggestion of Dr. Brown was proposed to be carried into effect by the provisions of that act, but it was soon ascertained that the most essential requirements of the law to be enforced by the consular officers of the United States at foreign ports were rendered inoperative by reason of the clause of section 3 which provided—

That none of the penalties herein imposed shall attach to any vessel, or any owner or officer thereof, till the act and the rules and regulations made in pursuance thereof shall have been officially promulgated for at least ten days in the port from which said vessel sailed.

For the Cuban authorities did not permit such promulgation to take place. This fact induced the Board, with the concurrence of the National Academy of Sciences, to recommend that the President be authorized to call an international sanitary conference, to meet at Washington, D. C., to which the several powers having jurisdiction of ports likely to be infected with yellow fever should be invited to send delegates, for the purpose of securing an international system of notification "as to the actual sanitary condition of ports and places under the jurisdiction of such powers and of all vessels sailing therefrom."

In compliance with this recommendation, a joint resolution of the Senate and House of Representatives was passed, and was approved by the President May 14, 1880. By this resolution the President was directed to call an international conference for the purpose specified by the Board, but the invitation was extended to all powers whose ports were likely to be infected with cholera or yellow fever, instead of being restricted to the latter. In an explanatory memorandum setting forth the circumstances which induced this government to ask those of other nations to join in the proposed sanitary conference, the Secretary of State adverted to the practical difficulty which had been encountered in the administration of the regulations and rules recommended by sanitary experience and framed by the legislation of the country to the end of preventing the introduction and spread of infectious diseases in the territory of the United States, the main difficulty arising from the refusal of the local authorities in certain foreign ports where infectious diseases prevailed to co-operate with the consular and medical officers of the United States. He specially invited attention to the fact that the joint resolution contemplated only securing "an international system of notification as to the actual sanitary condition of ports and places,"

and did not touch on the broader and more intricate question of the preventive sanitary measures imposed in the ports of each country, in conformity with its own laws and in proportion to the danger of outward communication and internal spread of epidemic disease at the port of introduction. He expressly disclaimed, on behalf of the Government of the United States, any purpose or wish to propose any international code of quarantine laws, even had the system of State and Federal governments in the United States favored bringing the sanitary precautions of the seaboard States, from Texas to Maine, with all their varying conditions, under one governmental code. He referred to instances in which, in consequence of the vague and untrustworthy evidence obtainable in some cases as to the sanitary condition of suspected foreign ports, vessels coming thence to the United States have, as it has afterwards appeared, been subjected to unnecessary quarantine in the ports of this country. On the other hand, vessels from non-infected ports of the United States have been compelled to submit to like unnecessary and vexatious delays by the quarantine regulations of other countries, based upon imperfect knowledge of the sanitary condition of American ports. He then announced, as the opinion of the President, that the great inconveniences and losses which the commerce of the world had been and was still suffering from the delays and obstructions caused by unnecessary quarantines could, to a great extent, be relieved by the establishment, as contemplated by the Congressional joint resolution, of an international system of notification as to the actual sanitary condition of ports and places likely to be infected with communicable or epidemic diseases.

Twenty-three States, in addition to Canada and the United States, responded to the invitation, and the conference was opened on the 5th of January, 1881. The delegates of the United States, though outvoted on some points of detail, were successful in obtaining a general recognition of the principle for which they contended, that the accredited agents of each government should have facilities for verifying the statements which would be contained in the bill of health delivered by the local authorities of foreign ports and *viséd* by its own agents. They were successful, too, in obtaining the adoption by the conference of a form of bill of health submitted by themselves, which form requires the authority which delivers it to furnish the most precise and detailed information as to the sanitary condition of the port and the surrounding country, and of the vessel, its cargo, passengers, and crew—all this, too, not in general terms, but under specified heads so numerous and so particular as to make it almost impossible to mislead the authorities of the port of arrival, except by willful misrepresentation and fraud on the part of those who furnish the bill.

The final act was signed March 1, when the conference was closed.

When the full proceedings of the conference, which have been ordered to be printed, shall have become accessible to the public, it will be seen that the delegates of the United States felt themselves constrained to oppose, by argument and by vote, any and every measure which, however praiseworthy in itself, might be liable to the construction of transcending the limits of discretion implied by the terms of the joint resolution of Congress. It is deeply to be regretted, in the interests of the public health of this country, that no steps have been taken by the Government of the United States, which called the conference together, towards submitting to the other powers a convention based upon the resolutions of the conference, with a view to utilizing the important concessions of international comity involved in some of those resolutions.

There is every reason to believe that a large majority of the powers are ready and anxious to become parties to such a convention.

In this connection the Board respectfully invites the attention of Congress to the following correspondence and statement of facts pertinent thereto:

HEALTH DEPARTMENT,
No. 301 *Mott street, New York, November* 28, 1881.

SIR: At a meeting of this Board, held on the 22d instant, the following preamble and resolution were adopted:

"Whereas cholera is prevalent at Mecca, and in the past an epidemic at that place, has been followed by the spread of this disease to Europe and to the United States: Therefore,

"*Resolved*, That the National Board of Health be requested (by means of existing laws or by legislation for that purpose) to inaugurate measures to prevent the spread of cholera to this country, and that co-operation with representatives of European governments to this end be, and is hereby, respectfully recommended."

A true copy.

EMMONS CLARK, *Secretary.*

JAMES L. CABELL, LL.D.,
President National Board of Health.

This communication having been submitted to the executive committee it was ordered that the president of the Board be authorized to address a communication to the President of the United States pointing out the difficulties which at present prevent any control at foreign ports on the part of the United States over vessels coming from such ports with infectious diseases, and which also prevent an enforcement of the obligation of such vessels, under the law of June 2, 1879, to obtain bills of health in the form prescribed by the National Board of Health, and suggesting that the attention of Congress should be called to the matter. Whereupon the following letter was addressed to the President, and delivered to his excellency in person, by two members of the Board, who made further explanations, and who understood him to say that he would send the papers immediately to the State Department, as the subject came properly within the line of its duties.

NATIONAL BOARD OF HEALTH.
January 4, 1882.

SIR: I am directed by the executive committee of the National Board of Health to invite your attention to the inclosed copy of a preamble and resolution of the board of health of the city of New York, in relation to the imminent danger of the transmission of cholera from Mecca, where the disease now prevails, to Europe, and thence to the United States.

It will be observed that the resolution in question calls upon the National Board of Health to inaugurate measures to prevent, by means of existing laws or by legislation for that purpose, the spread of cholera to this country, and furthermore earnestly recommends that the National Board of Health should to this end co-operate with representatives of European governments.

This suggestion on the part of the health authorities of the principal port of the United States is considered by this Board to be one of great and urgent importance; but in so far as it relates to "existing laws," I have to observe that their effective operation in respect of some of the most important instrumentalities for the prevention of the introduction of contagious and infectious diseases into the United States from foreign ports has hitherto been obstructed by the want of the necessary international co-operation. To secure this co-operation President Hayes, in pursuance of a joint resolution of Congress approved May 4, 1880, called an international sanitary conference, to meet at Washington, to which the several powers having jurisdiction of ports likely to be infected with yellow fever or cholera were invited.

Mr. Evarts, in submitting to the several powers a memorandum setting forth the objects of the joint resolution, stated that it had its origin in the practical difficulties which have been encountered in the administration of the regulations and rules recommended by sanitary experience and framed by the legislation of the country, to the end of preventing the introduction and spread of the yellow fever, cholera, and other contagious or infectious diseases in the territory of the United States.

The difficulties in their application have been chiefly owing to the fact that in certain foreign ports where infectious or contagious diseases have existed, or were supposed to exist, the local authorities have shown some hesitation as to co-operating with the consular and medical officer of the United States in carrying out regulations deemed essential by this government as a sanitary safeguard. The conference thus called by the President, met in Washington January 5, and ended its meeting March 2, 1881, but the delegates from the several States represented were not empowered to frame a convention.

The results of its deliberations were therefore presented merely as recommendations embodied in a series of resolutions which constituted the final act of the conference.

If these resolutions were now in actual operation the National Board of Health would have it in its power to obtain accurate and trustworthy information respecting the gradual approach of cholera to Europe and its spread to this country, and to enforce the rules and regulations approved by your excellency November 14, 1881, "for securing the best sanitary condition of vessels, including their cargoes, passengers, and crews coming to the United States from any foreign port where any contagious or infectious disease exists."

The danger referred to by the New York board of health appears to this Board to be so urgent as to justify the request, which is now respectfully made, that you will consider the expediency of inviting Congress to take the necessary steps, by joint resolution or otherwise, for inviting a second conference, to be empowered to frame a convention on the basis of the recommendations of the International Sanitary Conference of January to March, 1881.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

His Excellency CHESTER A. ARTHUR,
President of the United States.

This Board is not informed whether any action was taken by the State Department. Within the past few weeks of the current year the Board received the following very important communication from G. H. Heap, consul-general of the United States at Constantinople:

CONSULATE GENERAL OF THE UNITED STATES,
Constantinople, September 13, 1882.

NATIONAL BOARD OF HEALTH:

I transmit for your information copies of seven telegrams and letters which have been received and sent by the Imperial Ottoman Sanitary Administration on the subject of the progress of the cholera in India and Batavia, and its appearance at the quarantine stations on the Red Sea.

The confusion into which all branches of the administration in Egypt have been thrown by the present events in that country causes fears that the strict measures hitherto in force to prevent the passage of the epidemic from the Red Sea to the Mediterranean will be relaxed or disregarded through the exigencies of the war, especially as the season for the great pilgrimages to Mecca is approaching. The enfeebled condition of the foreign troops on service in Egypt, in consequence of their exposure to the effects of a torrid climate, corrupt water, and other causes incident to active military service in that country, will render the development of cholera very rapid should it gain a foothold among them.

Very respectfully,

G. H. HEAP,
Consul-General.

The letters and telegrams referred to in the foregoing communication make known the fact that numerous cases of cholera (all those reported were mortal) had appeared among the pilgrims en route to Mecca, coming by sea from Bombay by way of Aden, and that there were grave apprehensions of the introduction of the disease into Europe by way of the ports on the Red Sea. In view of the gravity of this communication in its prospective bearing upon the risks of the transmission of the disease into the United States by way of Europe, a communication was addressed to the President of the United States, requesting him to call the attention of Congress to the fact that the conclusions reached by the International Sanitary Conference of Washington are as yet merely recommendations, that it is desirable to confirm them by a convention between the participating powers, and that in the meanwhile it is urgently important that the law of June 2, 1879, should be so amended

that bills of health should be required of all vessels coming to any ports of the United States without imposing upon this government the burden of proving such ports to be infected, and that the penalties provided for violation of the law should apply without the proviso of a previous official promulgation of the law and of the rules and regulations made in pursuance thereof.

INTER-STATE QUARANTINE.

Next in importance to the quarantine service at maritime ports, conducted under the police powers of the States, is the Mississippi River inspection service, organized by the National Board of Health at the request and in aid of the health authorities of the various States and municipalities in the Mississippi Valley. The necessity for such a service grew out of the reasonable apprehensions of the people of that valley from New Orleans to Cairo and Saint Louis, that the disasters which they had experienced so often in the past, and especially in the fatal summer of 1878, by the transmission of yellow fever from New Orleans, might be repeated whenever the disease was introduced into that city. There was a settled determination by the constituted health authorities of Mississippi, Arkansas, Tennessee, Illinois, and Missouri to prevent this by every means in their power. Ordinances were passed prohibiting the landing of either freight or passengers from New Orleans, at the principal towns and cities on the river within a specified time, unless accompanied by a certificate from an inspecting agent of the National Board of Health at New Orleans, that the boat and its freight, passengers, and crew were all free from infection. They also insisted that these inspections should be repeated at certain points on the river, especially at Vicksburg and Memphis. The board of health of Louisiana united in the request for the establishment of this service, the value of which, in preventing obstructions to commerce, which was yet so regulated as to prevent the transmission of the seeds of disease, is conspicuously demonstrated in the report of Dr. R. W. Mitchell for the year 1880, published as an appendix to the Annual Report of this Board for that year. No one can read the testimony of the various railroad and steamboat transportation agents, and that of the Memphis Cotton Exchange, given in that report, without being forced to the conclusion that the operation of the service in question led to the saving of many millions of dollars each year. In the report of Dr. Fayette Dunlap, superintendent of the service in question during the present year, a copy of which marked K is herewith submitted, he adverts to the—

> Marked improvement over former years in the sanitary condition of the boats, plainly demonstrating that the officers and owners see the benefit of constant cleanliness of every part of their craft. The officers in charge show an eagerness to gain intelligent advice as to the best manner of ridding deck-rooms, water-closets, &c., of objectionable odors, and the means to be employed to check decomposition of the vegetable matter that unavoidably finds its way into the bilge, under dunnage and other hidden quarters of the boat.

Dr. Dunlap's jurisdiction as superintendent of this service extended from Cairo, Ill., to New Orleans, not, however, inclusive of the latter place, where Dr. S. E. Chaillé, of that city, was in charge.

It has just been stated that the health authorities of New Orleans, under the name of board of health of the State of Louisiana, had joined in the request of the sanitary council of the Mississippi Valley for the establishment of this service. They were well aware of the importance of the service to the continuance of the trade of that city with other places on the river, but apparently expected the agents of this Board to be exclusively

guided by their opinions and diagnosis in all cases of suspicious disease, for they resented as an insult and injury every effort made by the supervising inspector to ascertain the truth with regard to the sanitary condition of the city and the true nature of suspicious cases of fever. It is needless to say that had the National Board of Health consented to play a part which would have been a betrayal of the trust confided to it by the health authorities of the States of the Mississippi Valley, and by which the commerce of New Orleans was protected, no benefit could have accrued to the city from such a misplaced concession to the unreasonable demands of the local board of health. The certificates of the inspectors would instantly have been repudiated as a shallow device to deceive the health officers of the municipalities on the river above New Orleans.

These health officers insisted that New Orleans had no just claim to be considered the exclusive guardian of the mouths of the Mississippi, through which portals the infection of yellow fever had so often been introduced, not only into that city, but along the entire valley of the river; and, further, that if the authorities of New Orleans would not permit a quarantine of observation to be established under national auspices at Eadsport, with authority to prevent any infected vessel, or any vessel presenting evidences of reasonable suspicion of infection, from passing northward until certified to be free from infection by the inspectors of the National Board of Health, they would be constrained in self-defense to require the most thorough inspections to be made at the wharves of the city and certificates of the agents of this Board to be delivered as the conditions of being allowed to land either passengers or freight at any of the ports on the river shore.

This was the exclusive work of the sanitary authorities of the States interested, and the agency of this Board, which had been solicited by all parties concerned, including the board of health of Louisiana itself, was restricted to the work of making the inspections in good faith and delivering certificates accordingly. Nevertheless the Louisiana board of health, after joining in the request for the establishment and continance of this service by formal resolutions officially transmitted to the officers of this Board, has never lost an opportunity to find fault with and heap abuse upon both their distinguished fellow-citizen, the supervising inspector of the service in question, and all the officers of the Board for the discharge of their duties iu this connection. In proof of this charge, attention is invited to the unvarnished narrative of facts contained in the report of Dr. S. E. Chaillé, which is appended hereto, marked L.

In this connection it is pertinent to invite attention to the following letter addressed to the governor of Louisiana by the secretary of the State board of health of Illinois at a time when it was supposed that the health authorities of New Orleans would refuse to grant facilities to the inspectors of the National Board of Health for collecting trustworthy information as to the sanitary condition of the city. The declaration of a purpose to enforce a rigid quarantine against commercial and personal intercourse with New Orleans, "in the event of yellow fever being reported officially or *otherwise*," was no new revelation. This was well known to have been the settled purpose of every board of health having such authority in all of the Mississippi Valley States ever since the fatal epidemic of 1878; and it is due entirely to the agency of this Board, which has been so abused by the health authorities of New Orleans, that such a quarantine has not been enforced every summer since that date.

[Springfield (Ill.) Journal.]

The secretary of the Illinois State board of health has addressed the following letter to the governor of Louisiana, concerning the action of the New Orleans board of health in ignoring the request for a continuance of the river-inspection service during the yellow-fever season. It remains to be seen whether Governor McEnery will countenance such action by his board, in view of the certainty of New Orleans' commerce being practically shut out of the Ohio and Upper Mississippi upon the first rumor of yellow fever:

ILLINOIS STATE BOARD OF HEALTH,
Springfield, Ill., May 5, 1882.

His Excellency the Governor of the State of Louisiana:

SIR: To the better understanding of what follows, your attention is respectfully invited to this preamble and accompanying resolutions, a duly attested copy of which, as adopted by the Illinois State board of health at its regular quarterly meeting held at Chicago, April 13–15, 1882, was forwarded to the Louisiana State board on April 17 ultimo, the receipt thereof being acknowledged by its secretary under date April 22:

"Whereas it has been demonstrated that the geographical position of Illinois, and its relations with the Lower Mississippi country by rail and river, are such as to render the State subject to invasions of yellow fever, whenever that disease gets a foothold below; and

"Whereas it is believed that the exclusion of yellow fever from that region can only be effected through national agencies, operating for the general welfare without regard to State boundaries and uninfluenced by merely local considerations: Therefore be it

"*Resolved*, That the Illinois State board of health formally approves of the action of such State and local boards of health as have adopted the rules and regulations of the National Board of Health, and have conformed to its advice, suggestions, and requirements on this subject.

"*Resolved*, That this board renews its approval of the Mississippi River inspection service of said National Board of Health, and, in the event of yellow fever appearing on the Lower Mississippi during the coming summer, the secretary be, and he hereby is, authorized to make application to the National Board, in the name of the Illinois board, for the establishment and maintenance of an inspection station or stations of said service, to be located at such point or points as, in his judgment, are best calculated for the protection of the State.

"*Resolved*, That in such event no railroad or steamboat travel or traffic from any point or place within the compromised territory to any point or place within this State be permitted except in accordance with the rules, regulations, and requirements of the National Board of Health.

"*Resolved*, That the secretary be, and he hereby is, instructed to transmit duly authenticated copies of this preamble and resolutions to the secretary of the National Board of Health, and to the secretaries of the various State and local boards of health interested."

Official information being this day received to the effect that, owing to the attitude of the Louisiana State board of health, the inspection service approved of in the foregoing resolutions has not yet been re-established, and cannot be so long as that attitude is maintained, it becomes my duty, on behalf of the Illinois State board of health, the chief quarantine authority in this State, to notify your excellency, in your capacity as the chief quarantine authority of the State of Louisiana, that, in the event of yellow fever being reported, officially or otherwise, in the city of New Orleans or the State of Louisiana, it will be imperative upon the State board of health of Illinois to declare and enforce a rigid quarantine against commercial and personal intercourse with said city and State.

It is unnecessary to say that such action will be taken very reluctantly; but this board, by the attitude of the Louisiana State board, is left no alternative in the discharge of the duties imposed upon it by law, duties of the most vital and important character, namely, the supervision of the interests "of the health and life of the citizens of the State," and for the proper and efficient discharge of which high official responsibility it is clothed with plenary power "in all matters pertaining to quarantine."

Obviously it cannot hesitate to exercise this power, if, thereby, it may prevent a repetition of the avoidable loss of life, sickness, and suffering which resulted in some portions of the State, and the pecuniary sacrifices, commercial interruptions, and embarrassments, the panic and apprehension, which were afflicted upon this and adjoining States, as consequences of the last epidemic occurrences of yellow fever in New Orleans, to wit, in the years 1873 and 1878.

Should yellow fever again appear in the State of Louisiana, in the absence of an efficient inspection service such as that maintained during the past three summers with signal benefit in preserving confidence and a sense of security, there remains no safety

for the southern portion of this State save in absolute non-intercourse with the infected region. But while a quarantine of exclusion may be relied upon to do this, it will, of course, as in the past, so in the future, prove totally inadequate to prevent the frequent panic and alarm, bred of rumor, the distrust and apprehension always rife in the absence of impartial and accepted agencies of observation and information. Between "the interests of the health and life of the citizens of the State," however, on the one hand, and their commercial interests on the other, the duty and the obligations of this board are clearly defined.

This board has sought by such agencies as sanitary councils and conferences, by uniform systems of river and rail inspections, and by urging the assumption of national authority over maritime quarantines, whereby the sanitary control of national frontiers and highways should be administered in the interests of the whole country, and not exclusively in those of a city, State, or section, to make it possible to discharge its legal obligations with respect to health and life in such manner as not only not to interfere with but directly to facilitate and protect commerce and travel by making them safe from contagion and infection.

It is fitting and proper that these facts be recited in this connection in order that the responsibility for a quarantine of exclusion with its attendant annoyances, interruptions of travel and traffic, and not infrequent hardships, may be placed where it justly belongs.

A copy of this communication will be forwarded to such other State boards of health (and local boards) as have also requested the re-establishment of the inspection service, to the end that such uniformity of action as is still possible may be secured throughout the rest of the valley.

I am, sir, very respectfully,

JOHN H. RAUCH, M. D., *Secretary*.

IMMIGRANT-INSPECTION SERVICE TO PREVENT THE INTRODUCTION AND SPREAD OF SMALL-POX.

In the Annual Report of this Board for the year 1881, a brief notice was given of the circumstances attending the alarming prevalence in the Western and Northwestern States of small-pox, which had been introduced by immigrants coming from ports where the disease was known to exist. In most of these cases the exposure of the emigrants had not preceded the sailing of the vessel for more than a day or two, and as the incubative period exceeds the ordinary length of the voyage, the disease was seldom manifested until after the exposed persons had passed quarantine inspection at the ports of entry, when it would break out either while they were in transit by the railroads or after their arrival at various distributing centers in the Western States. Chicago was a principal sufferer in this way, but numerous other railroad centers suffered in a like manner, and the prospect of a large increase of immigration during the ensuing spring and summer, with the certainty of the continued existence of the disease in the principal ports of Europe from which emigrants embark for the United States, made it the duty of the Board to modify the "rules and regulation for securing the best sanitary condition of vessels, &c., coming to the United States from any foreign port where any contagious or infectious disease exists," so as to meet the special requirements in the case of this particular disease. These rules, which were to be enforced by the consular officers of the United States at foreign ports of departure, and additional rules and regulations necessary to prevent the introduction of small-pox into the United States, and recommended to be adopted and enforced at ports of arrival in this country by the proper health authorities of the States within which such ports lie, or in case such authorities shall fail or refuse to enforce this rule, then by some officer or other proper person to be designated by the President of the United States, were approved by the President in conformity with the provisions of the act approved June 2, 1879, entitled "An act to prevent the introduction of contagious or infectious diseases into the United States."

The consular agents of the United States were promptly informed by the State Department of the obligations imposed upon them by these rules and regulations, and they were directed to execute and enforce them. The gratifying facts were soon made apparent that the owners and agents of the immigrant lines of steamships were anticipating the promulgation and execution of these rules, and taking active measures to secure the vaccination of their steerage passengers. Very favorable results of this action were reported to the National Board of Health by the health officer of the port of New York, who, in his own official capacity, and on behalf of the State board of health of New York, had, as early as June 25, 1881, earnestly invited the attention of this Board to the importance of this subject, in the following communication:

HEALTH OFFICER'S DEPARTMENT, STATE OF NEW YORK,
Quarantine Station, S. I., June 25, 1881.

DEAR DOCTOR: I inclose to you a copy of the resolution adopted by the State board of health at its session the 23d instant.

You will have official notice in due time, I have no doubt; but, in view of the informal conference at Chicago the 29th instant, I have deemed it proper to send you a copy to-day.

In this place, let me suggest that one of the most useful subjects for the consideration of the conference referred to, would be the means by which quarantine and municipal authorities could secure the vaccination of all unprotected persons.

It is a subject demanding careful consideration in view of the legal embarrassments which may arise.

I hope the representative of the National Board in this State may be induced to attend, understanding as he does the necessities and difficulties of the whole matter, and as I cannot attend, owing to the pressing duties of my situation.

Very truly,

WM. M. SMITH,
Health Officer, Port of New York.

T. J. TURNER,
Secretary National Board of Health.

The following resolution was introduced at the recent meeting of the State board of health, on the 23d instant (June 23, 1881), by Dr. William M. Smith, and unanimously passsed:

Whereas it is believed that small-pox is at the present time prevailing as an epidemic in some of the ports of the British islands and of continental Europe; and

Whereas the emigration from those countries to the United States, principally through the port of New York, is at the present time unprecedented in its extent, and recognizing the fact that the incubative period of the disease is greater than the average passage of steamships from such ports to ports in the United States, thus affording an opportunity for emigrants infected at the port of departure to pass our quarantines and reach the interior communities before the development of the disease:

Resolved, That this board request the National Board of Health, as a necessary measure of interstate quarantine, to appoint an inspector of emigrants at Buffalo and Suspension Bridge, whose duty it shall be to examine all emigrants passing through or stopping off at the places mentioned.

And this board further respectfully recommend that the National Board of Health establish such inspections at Chicago, Pittsburgh, Saint Louis, and Omaha, during the epidemic prevalence of small-pox at the ports from which emigrants embark.

As soon as the "additional rules" to be observed at ports of arrival and at places along the lines of immigrant transportation had received the approval of the President on the 14th November, 1881, they were communicated to the health authorities of the various maritime ports of the United States. All promptly expressed their willingness to enforce them, but on the condition that they should be enforced at every port of entry. Some delay was experienced in securing the necessary concert, but at length this was obtained at a conference held at Port Huron, Mich., May 18, 1882, and immediately thereafter the immigrant-inspection service was inaugurated under the supervision and general

direction of Dr. Stephen Smith, of New York, a member of this Board, until at his own request he was succeeded in the performance of this duty by Dr. Hosmer A. Johnson, of Chicago, another member of the Board. The sole business of the officers on this service is to inspect immigrants with reference to their protection from small-pox, at several of the prominent sea-ports and the railway centers of the North. If the person examined be found to be satisfactorily vaccinated, or if being unprotected he now consents to be vaccinated, he is furnished with a protection card which is good until the next inspecting station is reached. Here the immigrant is again examined, and, if the previous vaccination has failed, as frequently happens, he is revaccinated, and so on, until he reaches his destination. In all this no compulsion is exercised, but any unprotected person who refuses vaccination is informed that the health authorities beyond the State lines will probably refuse to permit him to come within their jurisdiction unless he consents to be vaccinated. The *personnel* of this service under the auspices of the National Board consists of the following inspectors: One at the quarantine of New York, who acts in conjunction with the health officer of that port and with the agent of the State board of health; one at Philadelphia, one at Baltimore, and three at Port Huron, where the service is very heavy; one inspector at each of the following places: Hornellsville and Rochester, N. Y., Cleveland, Ohio, Pittsburgh, Pa., Grafton, W. Va., Indianapolis, Ind., East Saint Louis; three inspectors at Chicago, the principal distributing center of the Northwest.

The health authorities at Boston have not asked aid from the National Board of Health, but have adopted and faithfully enforced, at their own expense, the additional rules and regulations to prevent the introduction of small-pox into the United States.

The following instructions were issued for the guidance of the officers concerned:

INSTRUCTIONS TO INSPECTORS OF IMMIGRANTS.

(A.) Immediately upon the arrival or interception of any immigrant passenger train at your station, you will take note of the number of such cars, record of train and number of passengers, which you will obtain from the conductor; and you will immediately examine the passengers in the cars which are to be sent on—in case the train is broken—before the main portion of the train moves. Proceed regularly through the cars, examining each passenger, requesting to be shown the protection card issued at last station, and upon which you will indorse your initials, date of examination, and station, until further advised.

(B.) Upon discovery of evidence of small-pox upon any passenger, in any car, or at any station, the conductor is to be informed, and with his aid the patient should be isolated in the quarantine car and carried to the next proper refuge station as shall be or is already agreed upon with the local sanitary authorities. The passengers and materials in such car from which the patient has been removed shall be subjected to sanitary cleansing and disinfection. You will report the facts in the case to the local as well as to the State board within twelve hours.

(C.) All persons found exposed to small-pox contagion in any car, or at any station, shall be offered free vaccination.

(E.) In any instance of small-pox discovered on car or among emigrants, its source should be sought for, if practicable, and measures immediately taken to prevent further spread of the disease. In case the source is determined you will inform the Secretary of the State board concerning the essential facts ascertained.

You will particularly notice and make any required record of the condition and results of vaccinations which were made after the arrival of emigrants at the port of destination.

In every case of failure of such vaccination you should immediately proceed to revaccinate, following the same directions as in C.

These preliminary instructions will be subject to revision, and you are requested to communicate to the National Board of Health, through the State or local board of health, any defects in the system which, in your opinion, should be remedied, and such other suggestions occurring to you which will render the service efficient.

These inspections and vaccinations should be conducted while the train is in motion, or at the station, according as it may be most convenient, so as to cause the least detention to the movement of the train.

You are directed to carry out any additional regulations made by State or local sanitary authorities, provided such regulations are not in conflict with these general instructions.

Since the inauguration of this service, results such as are specified in the following official circular addressed to the inspectors in his district by Dr. John H. Rauch, secretary of the State board of health of Illinois, have been realized all along the lines of immigrant transportation where previously small-pox had prevailed to such an extent as to assume the proportions of an epidemic:

ILLINOIS STATE BOARD OF HEALTH,
OFFICE OF THE SECRETARY,
Springfield, Ill., July 15.

To the IMMIGRANT INSPECTORS, DISTRICT OF ILLINOIS:

GENTLEMEN: For the first time in eighteen months small-pox is practically under control in Illinois. That is to say, there has been but one solitary new importation of the disease into the State since the inspection service was begun on June 1. There are, however, fully 1,500 immigrants arriving and passing through the State every day, and one-third of these are even yet found susceptible to the disease and capable of propagating the contagion. From the experience of the past it is within bounds to say that there would have been at least *thirty separate centres of infection developed in this State alone during the past six weeks had it not been for this inspection service.*

The refusal of Congress to appropriate the funds necessary to enable the National Board of Health to continue this work has caused the latter body to order a suspension of the service on and after to-day. Such a suspension means a renewal of the exposure of Chicago, of Illinois, and of the region beyond to the imported infection by which they have always been threatened and frequently invaded whenever there was much immigration. Hitherto it has been found impossible to prevent the repeated introduction of the disease by this class of persons.

Reliance on the seaboard quarantines has proved as baseless for the Northwest with regard to small-pox as for the Mississippi Valley with regard to yellow fever, or the country at large with regard to Asiatic cholera. As a rule, whenever any one of these diseases has been epidemic in countries in close commercial relation with our seaboard or Gulf ports it has speedily passed such ports into the interior. The seaboard quarantine laws are imperfect, and their administration is inefficient. The interior should no longer be asked to endure the sufferings and losses entailed by such defects and inefficiency, or forced to quarantines of detention and exclusion which are only less costly and vexatious to the quarantiner than to the quarantined.

A feasible and successful method has been demonstrated for the protection of the Mississippi Valley against yellow fever and of the West and Northwest from small-pox, namely, a system of sanitary inspections carried on without obstruction of commerce or travel; covering the whole of the exposed territory without regard to State boundaries; regulated by a national organization independent of other considerations than those of the public health; and maintained, as such a service legitimately should be, by the National Government—as legitimately, at least, as a light-house, or harbor improvement, or life-saving or any other service for the general welfare.

With the present defective—in many cases obsolete—local and State quarantine laws and their vacillating and inefficient administration, and especially in these days of rapid transit, when, in point of time, Chicago is nearer Europe and its epidemics than New York was thirty years ago, and Southern Illinois nearer the indigenous zone of yellow fever than Louisiana was when the principles of her present quarantine system were first adopted, some such system of continuous sanitary surveillance, operating between the ports of arrival and points of destination, has become absolutely necessary for the protection of the interior from the introduction of foreign contagion.

The abolition of the inspection service at the very time when its value has been unquestionably proved is an inexcusable trifling with the health interests of thirty millions of people, aside from any consideration of the effect upon commerce and the great grain and provision markets of the withdrawal of what had already come to be relied upon for truthful and authoritative announcements of the presence or absence of danger.

That no epidemic of yellow fever now exists in the Southern States, or that the small-pox epidemic in the West and Northwest is at length under control, is no justification for abandoning the principal agency by which the one has been prevented and the other to a great extent suppressed.

The very essence of State medicine lies in prevention; and it would be as wise to disband a fire department and dismantle the engines and water service while a fire

was still smoldering, but ready again to break into flames, as it is now to close inspection and refuge stations and abolish this service while yellow-fever ships are arriving at Southern and Gulf ports, and cargoes of small-pox *materiel* are daily being distributed throughout the Northern States.

Actuated by the foregoing considerations, and in the interests of the public health not alone of Illinois but of all the region beyond, the Illinois State board of health, with the co-operation of the health departments of Indianapolis, Saint Louis, and Chicago, will assume the responsibility of continuing the inspection of immigrants arriving in this district for the present.

The withdrawal of inspectors from the stations east of this district will necessitate a careful personal examination of each individual; and the number requiring vaccination or other preventive treatment, as well as of actually-developed cases of small-pox likely to be met with, will be greater, since little or none of this work will have been done previously. This will make the service much more onerous both for the inspectors and for the railways, and more time will be required for inspections than hitherto.

If necessary to accomplish the work properly before arrival in the cities above mentioned, the side-tracking and detention of any train is hereby authorized. As heretofore, small-pox cases in transit will be removed from the trains and duly cared for at the nearest appropriate point after discovery. Weekly reports will be continued, and in these, in addition to nationalities of immigrants, names of steamships, dates and ports of arrival, condition of individuals, cars, &c., special mention will be made of the character and results of the work performed by steamship surgeons.

The steamship companies have the power to secure the almost absolute immunity of their steerage passengers from small-pox or their liability to convey the disease. If they notoriously fail in this regard, justice demands that such publicity be given to the failure and its results as will tend to limit the evil in the future.

As far as practicable, the movements of trains will not be interfered with. The railroad companies have given such cordial support to this measure that they are entitled to every consideration consistent with the proper protection of the public health. Inspectors are specifically instructed to do all in their power to avoid any interruption of travel.

Finally, inspectors are reminded that their duties involve not only the protection of their immediate districts, but that the exclusion of imported small-pox from Illinois furnishes the largest measure of protection to the region west, northwest, and southwest. No immigrant capable of conveying the disease, either into or beyond the State, must be neglected.

JOHN H. RAUCH, M. D., *Secretary.*

At the date of this circular it was supposed that it would be impossible to continue the service beyond that day, but the subsequent extension of the appropriations for the last fiscal year to the 7th of August placed it in the power of the Board to continue its operations until an amendment to the sundry civil appropriation bill, reported from the committee of conference, was adopted by both houses of Congress. This amendment added $25,000 to the amount originally voted by the House of Representatives, and made the whole available as well for the suppression of small-pox as for that of yellow fever and cholera.

For a detailed exhibit of the operations of the Board in connection with this important service, attention is respectfully invited to the reports of the inspectors in Appendix M; where also will be found an interesting communication from Dr. William M. Smith, health officer of the port of New York, on the desirability of continuing the inspection of immigrants.

EFFORTS TO PROCURE AMENDMENTS TO THE ACT OF JUNE 2, 1879.

One of the causes of the delay in inaugurating the immigrant-inspection service was the desire, alike of the National Board and of most of the State and municipal boards of health interested in this subject, to procure an amendment to the law of June 2, 1879, which would enable the law officers of the government to enforce the rules and regulations made in pursuance thereof, and especially the additional rules for the prevention of the introduction of small-pox. Some of the most

important provisions of the law had proved to be nugatory by reason of the fact that they placed upon this government the burden of proving the existence of infectious disease at any given foreign port. To meet the difficulties arising from this source the following communication was addressed to the President, after a conference with a delegation from Illinois and the two Senators of that State:

NATIONAL BOARD OF HEALTH,
March 10, 1882.

SIR: I am directed by the executive committee of the National Board of Health to report to your Excellency that this office has received reliable information that small-pox is still prevailing to an alarming extent in many States along the lines of transportation of immigrants.

The special dangers arising from this source appear to be twofold. Particular localities are imperiled by the actual introduction of the disease from abroad, and the enormous influx of persons unprotected by previous vaccination supplies the condition for the certain spread of the infection and its transmission from one State into another. It is believed that both sources of danger will continue to exist in increasing proportions during the current year. The experience of the last few months has demonstrated the fact that the act entitled "An act to prevent the introduction of contagious and infectious diseases into the United States from foreign countries and from one State into another," approved June 2, 1879, as well as the rules and regulations made by this Board in conformity with the provisions of that act, and approved by your Excellency November 14, 1881, are inoperative for the reason that they apply only to infected ports, and that the law officers of the government find it difficult or impossible to obtain legal proof of the fact of infection at the date of sailing of any given vessel.

Furthermore the act does not make adequate provision for the evil of which the local health authorities chiefly complain, that, namely, of the continued influx of unvaccinated immigrants. The collection of large numbers of susceptible subjects in circumscribed localities into which the infection had been previously introduced makes it inevitable that the disease shall not only spread within the limits of these localities, but also that it shall be transmitted into neighboring States.

The former difficulty will be met by such amendments to the act of June 2, 1879, as will make its provisions applicable to all vessels sailing from any foreign port without imposing upon the government the obligation to prove that such port is infected. The other evil would seem to require for its effectual cure a specific provision requiring the vaccination of all immigrants not previously protected, as an apparently necessary means of preventing the introduction and continuous development of small-pox in the United States.

The executive committee would further recommend that every vessel clearing from any foreign port should be required to obtain a bill of health in the form prescribed by the National Board of Health, which form met the approval of the International Sanitary Conference of Washington, March 1, 1881.

If the suggestions of such amendments meet the approval of your Excellency, it is respectfully requested that you will in a special message to Congress call the attention of that body to the urgency of the danger and recommend suitable action at the earliest practicable moment.

I am, very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

His Excellency C. A. ARTHUR,
President of the United States.

In accordance with this request, a special message transmitting to Congress the suggestions of the Board was made by the President on the 16th of March, when the subject was referred to an appropriate committee, from which Senator Harris subsequently reported an amended bill (S. 1049), which has not yet been acted on.

MISCELLANEOUS OPERATIONS OF THE BOARD.

QUARANTINE AT SAN FRANCISCO, CAL.

A letter from the Chinese consul-general, F. A. Bee, dated at San Francisco, Cal., June 6, 1882, called the attention of this Board to the defective quarantine "arrangements" at the port of San Francisco, as

illustrated by the recent case of the Altonower, on board of which over 800 Chinese passengers had been kept exposed to the contagion of small-pox. This letter was transmitted to the President, and in accordance with his directions a commission consisting of three medical officers, one each from the Army, the Navy, and the Marine-Hospital Service, was assembled to determine what changes, if any, may be necessary for the protection of the public health, and also to consider and recommend a suitable site for the establishment of a national quarantine station, should such a station be found necessary. The report of this commission is to the effect that the San Francisco quarantine regulations are satisfactory, but that they are virtually a dead letter, as no appropriations have been made to carry them into effect, and that the only suitable and available site is a cove between Peninsula and Tiberon points, in Raccoon Strait, between Angel Island and the mainland.

Certain letters and documents appended to the report show that the deficiencies of the local quarantine are appreciated by the city and State health authorities, and that efforts have been made to remedy them by both of these bodies. Two years ago the city board of health communicated through the State authorities with this Board, and a committee of military officers was directed to examine and report if an available site for quarantine purposes could be found. A bill was also passed at the last State legislature authorizing the governor to appoint a committee of the State board of health to examine the harbor for a site and report the result at the next session. Here the matter rested, so far as the State is concerned, when it was again brought forward by the case of the Altonower. This particular case has reference only to small-pox, but when the devastation effected by cholera in Japan since April last is considered in connection with the intercourse between Yokohama and San Francisco, and the railroad facilities between the latter port and the whole of the United States, the subject assumes a larger proportion, and in the event of inability on the part of State or municipal authorities to establish a local quarantine a recommendation by this Board for the establishment of a refuge station on the Pacific coast seems called for by the general interests of the country. The papers to which reference has been made will be found in Appendix N.

AID TO THE DISTRICT OF COLUMBIA.

In the winter of 1879–'80 small-pox, which had been introduced into the District, showed a marked tendency to become epidemic on account of the number of unvaccinated persons accumulated within its precincts. This threatened flame was "stamped out" by the vigorous measures which the health office was enabled to carry out, with aid from this Board. Since then the District has enjoyed an immunity from the disease, although during the period the country generally was suffering from it, and many neighboring cities were notably infected. Occasional cases were imported into Washington, but its vaccinal protection was such that in no case did the disease extend to a resident of the city until January 12 of the present year, when several unvaccinated persons, who came in contact with an importation from Connellsville, Pa., became infected and sickened. This created some alarm in the minds of non-professional men, but with the aid of this Board the health officer of the District arranged for the protection of the unvaccinated, and established his hospital and its allied ambulance and disinfecting services with the most satisfactory results. Before the vaccinations were effected a few cases propagated their infection in the city, but as soon as the vaccin-

ators were fairly at work this propagation ceased, and the history of each imported case began and ended with itself.

The vaccinations were performed by the physicians to the poor and by a medical man specially paid for this duty at the health office. A total of 29,158 persons were vaccinated, of whom 8,948 were primary cases and 20,210 revaccinations, with 69 per cent. of successes, 21 per cent. of failures, and 10 per cent. of unknown results.

In view of the wide-spread occurrence of small-pox throughout the country it was considered probable that for several months the small-pox hospital would have to be kept open for casual cases brought in from other localities or for cases which might originate from them. To meet this probability aid was extended to the local health office until June 30, when the service was discontinued on account of the freedom of the city from infection. During this period 38 cases, mostly imported, were taken to the hospital. The efficiency of this small-pox service can be appreciated when the distribution of the cases is stated. Four cases were removed from the northwest division, 6 from the northeast, and 14 from each of the southern divisions. The service cost $4,656.06.

AID TO PENSACOLA, FLA.

The health board of Pensacola, Fla., on August 28, officially announced the presence of yellow fever in that city. On the 30th communication was opened with the National Board of Health by a telegraphic request for assistance. In response, estimates were called for, and, these being expected by telegraph, the executive committee of this Board held itself in readiness to act upon them promptly, but they were not made up until September 7. This delay on the part of the city authorities was regarded as indicating their confidence in being able to stamp out the disease. On this day the fever began to spread more rapidly, and the local board, becoming anxious for assistance, telegraphed to that effect, their estimates meanwhile having been delayed by quarantine restrictions. An immediaate answer was given, which was acceptable to the city authorities, although the amount was insufficient to cover all the expenditures which they considered needful. Disinfectants, including sulphur, copperas, and carbolic acid, had already been sent to Pensacola from a supply stored at Memphis. Aid was extended to cover the bills for nursing until October 15—up to which time the cases treated numbered 1,607, of which 140 had proved fatal. The amount expended in this service was $6,940.55. In acknowledging the settlement of these accounts, the secretary of the board of health remarks:

> Our expenses are very great, but with the assistance of the National Board, by whom our condition seems to have been understood, and the contributions of the generous public thus far received, every call of distress and every cry of hunger have been alleviated.

Up to this time no details of the operations of the local board, or of the progress of the disease through the city, have been received. An investigation into the origin of the epidemic has recently been instituted by this Board.

YELLOW FEVER AT BROWNSVILLE, TEX.

During the summer yellow fever effected an entry into Brownsville, Tex., from some of the Mexican ports, where it is indigenous, by way of the Rio Grande, either directly from Matamoros or indirectly by some of the higher crossings. Aid was extended to the infected localities by the supervising surgeon of the Marine-Hospital Service, to whom the disbursement of the fund, appropriated on the estimates of this Board for such a contingency, was assigned. The attention of Congress is in-

vited to the fact, testified to by those who are cognizant of the epidemiology of yellow fever in that section, that while an inspector of this Board was on duty at the mouth of the Rio Grande the fever was excluded, although the conditions predisposing to invasion were as apparent during that period as they were at the time when the disease effected its entrance. In this connection, the following communications are submitted with the recommendation that in the absence of an international quarantine, by which the mouth of the river may be guarded, the Board may be enabled to place an inspector there, as in former years:

DEPARTMENT OF STATE,
Washington, September 4, 1882.

SIR: I have to inclose, herewith, for your information, copy of a letter from his excellency the Governor of Texas, of the 25th ultimo, requesting a joint or co-operative quarantine regulation upon the Rio Grande, including its mouth, which should be embodied in a new treaty with Mexico, to negotiate which commissioners have been nominated and confirmed; also, copy of my reply to Governor Roberts.

In communicating to you the inclosed correspondence, I take occasion to say that the department would gladly receive an expression of the views of the National Board of Health upon the subject and any additional facts relating thereto with which you may be pleased to favor it.

I am, sir, your obedient servant,

JOHN DAVIS,
Acting Secretary.

JAMES L. CABELL, M. D.,
President National Board of Health,
Washington City, D. C.

(Inclosures:) Governor Roberts to Mr. Frelinghuysen, August 25, 1882; Mr. Davis to Governor Roberts, September 4, 1882.

Governor Roberts to Mr. Frelinghuysen.

EXECUTIVE OFFICE,
Austin, August 25, 1882.

SIR: I see it in the newspapers that it is contemplated to make a treaty with Mexico concerning certain matters. I would respectfully request that the subject of a joint or co-operative quarantine upon the Rio Grande, including its mouth, be considered and acted on in said treaty.

For the last three years previous to this year, while General Canales was in command at Matamoros, we were enabled to act in harmony on that subject, by which the yellow fever was kept out of Texas on that border. Since his death no such arrangement has been satisfactorily made. In consequence of that the yellow fever brought to Matamoros has been communicated to Brownsville, in Texas, where it is now prevalent as a terrible epidemic. The Mexicans seem to have but little fear of this fever, and take but little precaution to prevent its spreading from Vera Cruz and other Mexican ports, where it prevails every year.

The towns on the Rio Grande are built on the banks of the river, usually close to the river on both sides, and there is a continual passing of the population of both countries from one side of the river to the other. It is more so because a large portion of our population on the Rio Grande are Mexicans. At Matamoros a great deal of the commerce is carried on through Brownsville, in Texas, from Brazos Santiago, a Texas port. Still some of it comes up the river from the mouth, where Texas has no right to establish such a quarantine as would prevent Mexican coasting vessels going up the Rio Grande to Matamoros on the river. In addition to this, railroads are now running and being built to run from Texas into Mexico, which will greatly increase the intercourse between the two countries, and increase our liability to have the yellow fever brought from Mexico into Texas. It is a well known fact that, if yellow fever should be brought into any of the towns on the Rio Grande on the Mexican side, it is next to an impossibility to prevent it from entering Texas from Mexico.

You will much oblige the people of Texas to have the President of the United States to consider this subject, so that he may give directions for a provision in the treaty regulating it. The National Board of Health, I doubt not, is well informed on this subject, and, if referred to, will concur with me in the estimate of its importance to Texas as a part of the United States.

Respectfully, &c.,

O. M. ROBERTS, *Governor*

Hon. FRED'K T. FRELINGHUYSEN,
Secretary of State.

Mr. Davis to Governor Roberts.

DEPARTMENT OF STATE,
Washington, September 4, 1882.

SIR: I have the honor to acknowledge the receipt of your excellency's letter of the 25th ultimo, suggesting the propriety of embodying a joint or co-operative quarantine regulation upon the Rio Grande, including its mouth, in the proposed treaty with Mexico, concerning the negotiation of which the newspapers have recently reported.

Your excellency's letter has been read with much interest, and the importance of its subject is greatly appreciated. A new treaty of commerce between the United States and Mexico is probably the one to which you refer, and to conclude which General U. S. Grant and Mr. Henry Trescot have been nominated and confirmed as commissioners under the recent authority of Congress; but a provision, such as you describe, would, it is thought, hardly find place in an engagement of that nature between those governments.

Nevertheless, with a view of giving the whole subject that careful attention and consideration which its importance seems to require and without unnecessary delay, the department would be glad to receive any further suggestions which you may deem it advisable to submit and which may be of material aid, particularly some explanation of your quarantine arrangement with the late Mexican General Canales, and to which you allude.

I shall also avail myself of the advice of the National Board of Health in regard to the matter, and to that end have communicated to it copy of your letter, and have asked that it furnish this department with an expression of its views touching the subject, as well as with any additional matters relating thereto.

I have the honor to be, sir, your excellency's very obedient servant,

JOHN DAVIS,
Acting Secretary.

His Excellency O. M. ROBERTS,
Governor of Texas, Austin, Tex.

In reply to this communication it was stated that in the opinion of the National Board the importance of protecting the public health by some such measure as was foreshadowed in the suggestions of Governor Roberts, could scarcely be exaggerated. It was further stated that shortly after the organization of the Board the fact was ascertained that the Mexican Government had no legally established quarantine on the Rio Grande, but that General Canales was willing to allow certain facilities for the sanitary inspection of vessels at the port of Bagdad to his personal friend Dr. Combe, a citizen of the United States. Thereupon, by the advice and request of the health authorities of Texas, Dr. Combe was appointed sanitary inspector at the mouth of the Rio Grande by, and at the expense of, this Board. This arrangement would have been continued during the present summer had there been a renewed request on the part of the Texan authorities, and had the Board possessed adequate means.

At the same time occasion was taken to refer the honorable Secretary of State to the fact that certain very important concessions of international comity had been incorporated in the final act of the International Sanitary Conference of Washington, which, if ratified by this and the other participating powers, would prove to be extremely valuable towards preventing the introduction of infectious diseases from foreign ports into this country.

THE BULLETIN OF THE NATIONAL BOARD OF HEALTH.

Section 4 of the act approved June 2, 1879, after making it the duty of the National Board of Health to obtain information of the sanitary condition of foreign ports and places from which contagious and infectious diseases are or may be imported into the United States, directed the Board to prepare, publish, and transmit to the medical officers of the Marine-Hospital Service, to collectors of customs, and to State

and municipal health officers and authorities, weekly abstracts of the consular sanitary reports and other pertinent information received by the Board.

To fulfill the requirements of this law the first number of the Bulletin was published on June 28, 1879. From that date it was issued regularly, until its suspension in July of the present year was necessitated by the failure of Congress to appropriate for its support. It was transmitted to State and municipal health authorities, and to all who showed their interest in sanitary matters by voluntarily co-operating in gathering information relating to the climatic and other conditions affecting the public health, conveying to them a summary of the sanitary condition of the country and of such foreign ports or places as are of importance in connection with the spread of epidemic diseases. Many valuable reports and papers have appeared in its columns, or been published supplementary to it. It supplied a want which had long been felt in this country. Free communication between local health officers was impossible on account of the amount of clerical work involved. The Bulletin issued from a central office or sanitary exchange effected this communication, and permitted health officers and boards to profit by the current experiences of communities other than their own. It gave an impetus to sanitary work by diffusing the knowledge necessary to its efficient accomplishment, and it promoted the formation of health boards in many sections of the country. In the presidential address to the American Public Health Association at Indianapolis, Dr. Kedzie of Michigan, in enumerating the causes for hopefulness for the immediate future of public sanitation, remarks that—

> So many State boards have been organized that now we count up to see how many States have no board, instead of enumerating the number that have.

When the issue of the Bulletin was suspended many expressions of inquiry and regret were received by the secretary of this Board from sanitary workers, together with resolutions of similar tenor from health organizations and medical societies; and although the Bulletin could not be considered a publication of much interest to non-professional men, not a few of the daily papers made note of its suspension, and regretted the policy which had caused it.

But perhaps the strongest recognition of the usefulness of the information which it furnished is to be found in the applications made to the Board by the managers of three sanitary journals to be supplied with the statistical and other data for publication in their columns.

Mr. H. C. Meyer, of the Sanitary Engineer, in issuing the first number of his paper containing abstracts of the information accumulating from week to week in the office of this Board, remarked:

> When the announcement that the Congress of the United States had refused to grant the appropriation needed to defray the expenses of continuing the publication of the Bulletin of the National Board of Health reached us we were in Europe. The expressions of regret at this action we there heard, and the complaints from all parts of this country that have since reached us from those capable of appreciating the value of these records induced us to propose to the National Board of Health that we would give space to print the most important information heretofore published in the Bulletin if the Board would place at our disposal such data as would enable us to make the necessary compilations. * * * It seemed to us desirable to keep together the corps of correspondents of the Board, many of whom might be unwilling to continue sending information not likely to be promptly available for public inspection and comparison.

But, as no private journal can adequately satisfy the necessities of the country in this respect, the Board earnestly but respectfully recommends the restoration of this valuable publication

GROUNDS OF THE OPPOSITION TO THE NATIONAL BOARD OF HEALTH.

It is not proposed in this connection to attempt a formal argument in favor of the continuance of a national public health organization. It is to be assumed that the passage of the constituting act of March 3, 1879, in the last hours of the session of Congress, gave evidence of the recognition by that body of its duty to provide for the protection of the public health by the creation of a sanitary board charged with such duties as the experience of the enlightened governments of Europe had shown to be appropriate. If the principle of judging the tree by its fruits be applied with fairness and without prejudice to the operations of the present board, which has received the cordial indorsement of all the medical and sanitary associations of the country and of the National Academy of Sciences, its members have no fear that the conclusions, whether with respect to the general policy or to their own agency in the work, will be otherwise than such as to command a verdict of approval. But it is considered proper to notice a few of the most prominent charges made against the present Board, and to correct the errors on which they are based.

1. One of these charges is that the Board, having been organized with special reference to the diseases of cholera and yellow fever, and the reasons that called for its creation having ceased, it is now useless, and is, or ought to be, *functus officiis;* and that in continuing its operations it transcends the original limits designed by the law.

Not to advert particularly to the practical commentary on a part of this charge furnished by the actual prevalence of yellow fever at two of the ports on the Gulf coast and the grave apprehensions entertained by judicious sanitarians as to the prospective danger of importation of cholera from Europe, which is likely to experience an invasion from the East by way of the Red Sea, it may be remarked that such a charge rests upon the evident error of confounding the act creating the National Board, which was approved March 3, 1879, with many other bills which had previously been introduced but which were never enacted. All of these bills proposed to confer quarantine powers on the Marine-Hospital Service, and these powers had relation to the prevention of the introduction of yellow fever and cholera. It appears that none of them found favor with the National Legislature. It is true that the McGowan bill, which was enacted during the last day of the session and approved by the President on the same day, was entitled "An act to prevent the introduction of contagious and infectious diseases into the United States, and to create a National Board of Health," but it contained no provision for fulfilling the promise held out by the first part of its title. No quarantine authority, not even the authority to assist local boards of health, was conferred by it; and the only allusion to the subject of quarantine was found in the section which required the Board, assisted by the National Academy of Sciences, to report to the next session of Congress on a system of national quarantine, and the relations which should exist between such a system and the State quarantines.

The duties assigned to the Board under the act in question were of the most general nature and are prescribed in the following terms:

> Said Board shall make or cause to be made such special examinations and investigations at any place or places, within the United States, or at foreign ports, as they may deem best, to aid in the execution of this act and the promotion of its objects.
>
> SEC. 2. The duties of the National Board of Health shall be to obtain information upon all matters affecting the public health, to advise the several departments of the government, the executives of the several States, and the Commissioners of the District of Columbia, on all questions submitted by them, or whenever, in the opinion of the Board, such advice may tend to the preservation and improvement of the public health.

That such language conferred the authority and prescribed the duty on the part of the Board to cause to be made such special scientific investigations as have been in progress during the last three years there cannot be a doubt. They are precisely such investigations as are recommended and are made by every similar organization all over the world, and it is well known that it was the intention of the author of the bill to prescribe just such investigations. It may be added that so far as is known to this Board no objection of this kind was raised during the first three years after the law went into operation, although in every annual report there was an enumeration not only of the investigations then in progress, but of several others which it was intended to make in the near future.

Of their value with reference to the advance of sanitary knowledge and the improvement of the means of controlling disease there had never been a shadow of doubt among the most experienced and practical sanitarians. Not only this Board but every State board of health in the United States which was supplied with the necessary funds has endeavored to follow the example of the local government in England in selecting competent experts to conduct scientific investigations on sanitary subjects, a practice which was carried out in that country under the auspices of the medical officer of the privy council, and has produced a series of the most valuable papers, with the result of "shaping professional and public opinion in sanitary matters, not only in England, but in all civilized countries where such matters receive any attention." Mr. Simon, the medical officer in question, on resigning his office made an earnest appeal to the local government board to continue them under the administration of his successor, with the statement that he entertained the—

Strongest conviction that in regard of all antagonisms to disease, whether with preventive or curative measures, and whether by official or private hands, medicine's best prospects of increased success are inseparable from such studies of exact science, and that, in proportion as the pathological insight becomes more clear the growth of practical power will certainly follow.

In complete accord with this estimate of the practical value of such scientific investigations, the National Academy of Sciences, which had been required by the act creating the Board of Health to co-operate with said Board in the preparation of its First Annual Report, addressed a separate communication to the two houses of Congress, December 27, 1879, containing a number of recommendations, of which the following was one:

3. That the Board should continue the special investigations already undertaken by it, as mentioned in its annual report; and that, in addition to these, other investigations should be undertaken by it, or under its direction, upon the subjects of cholera, malaria, typhoid and typho-malarial fevers, diphtheria, and cerebro-spinal meningitis. In addition to these investigations, there should also be carried on sanitary surveys of places remarkably unhealthy or liable to become so. The only limitation which should be placed on these investigations and surveys should be the amount of funds appropriated for that purpose. It is believed that, for the present, the sum to be annually allowed for such investigations and sanitary surveys should be $30,000.

No murmur of dissent from this recommendation of the National Academy of Sciences, in a report transmitted directly to Congress and printed, was ever heard.

It is thus quite evident that in causing such investigations to be made the Board merely complied with the requirements of the law, and for three entire years had every reason to suppose that they were sanctioned and approved by the National Legislature.

It only remains to be added that the papers embodying the results of the investigations have received the tribute of the highest commenda-

tion of sanitarians at home and abroad. Several of them have been characterized as among the most important contributions to the cause of practical sanitary science which have ever been made.

2. Another charge against the Board is its alleged extravagant waste of the funds placed at its disposal.

It was stated that on the assembling of Congress in December, 1879, it was found that the Board, which had been organized early in the preceding April with an appropriation of $50,000 under the constituting act, to which the large sum of $500,000 had been added under the act of June 2, 1879, had already made contracts, not only consuming the whole $500,000, but they had to come forward and ask for a deficiency of $300,000 or $400,000. This was an extraordinary and serious mistake. Some weeks prior to the time at which this erroneous statement was made Senator Harris, of Tennessee, in a printed report from the special Senate committee on the best means of preventing the introduction and spread of epidemic diseases, had stated from the record the positive fact that—

> The expenses of the Board for the first *three* years of its existence, ending April 3, 1882, aggregate $506,216.17, or the average of $168,738.72 per year, the entire expenditures for the three years being about $44,000 less than the amount appropriated for the first year.

In point of fact the total expenditures of the Board from the date of its organization to December 31, 1879, one month later than the time designated as that at which it had made contracts to the full amount of $500,000, with a deficiency of $300,000 or $400,000, were exactly $154,002.42. When it is remembered that yellow fever existed as an epidemic in Memphis during the entire summer of that year, that there was quite a serious outbreak in New Orleans and other places in Louisiana, and at several points in Mississippi and Arkansas, for the treatment of which the sum of $47,742.03 was expended in Tennessee, $13,628.30 in Louisiana, $13,180.24 in Mississippi, $7,539.51 in Arkansas, besides lesser amounts, making a considerable aggregate, in neighboring States which were threatened, it will be perceived that the expenditures for the general purposes of the Board, including the printing and distribution of 5,000 copies of the Bulletin weekly, were marvelously small.

The following table exhibits the annual expenditures of the Board, arranged under several heads:

Statement of the expenditures of the National Board of Health from April 1, 1879, to June 30, 1882.

On what account.	From organization to June 30, 1879.	Year ending June 30, 1880.	Year ending June 30, 1881.	Year ending June 30, 1882.
Floating quarantine on Mississippi River	.....	$40,238 11	$38,040 18	$17,796 42
Ship Island Station	.....	18,988 89	34,203 13	12,743 62
Sapelo Station	.....	6,669 48	10,479 31	9,949 92
Elizabeth River, Virginia	.....	3,812 16	3,246 54	1,259 88
Aid to Pensacola, Fla	.....	3,006 28	4,444 88	.....
Aid to Pascagoula, Miss	.....	3,791 19	97 58	.....
Aid to Hancock County, Mississippi	.....	.....	619 35	.....
Aid to Harrison County, Mississippi	.....	.....	766 90	.....
Aid to State board of health of Louisiana	.....	11,384 68	1,901 90	.....
Aid to State board of health of Texas	.....	115 00	275 00	.....
Aid to Charleston, S. C	.....	38 60	7,585 32	112 80
Havana Commission	$925 69	11,336 97	662 30	.....

Statement of the expenditures of the National Board of Health, &c.—Continued.

On what account.	From organization to June 30, 1879.	Year ending June 30, 1880.	Year ending June 30, 1881.	Year ending June 30, 1882.
Pay and expenses inspectors at Havana and other places	.....	$31,459 39	$11,204 92	$3,011 70
Special scientific investigations	.....	14,496 59	10,192 83	8,715 31
Pay and expenses of members of the National Board of Health	$4,044 25	12,736 27	8,845 87	5,069 68
Printing of Bulletin of National Board of Health, blanks, &c	669 99	6,882 73	9,984 62	9,992 38
Pay of secretary, disbursing agent, clerks, messengers, &c	1,678 10	18,258 02	18,656 56	17,802 19
Rent, light, and fuel	.....	1,009 28	1,564 43	1,457 59
Telegrams	29 21	1,678 34	322 53	238 79
Furniture, stationery, &c., for National Board of Health office	620 89	2,316 76	2,685 27	1,159 64
Miscellaneous expenses of the National Board of Health	1,086 03	4,577 83	1,157 48	798 69
Postage	92 25	702 26	260 60	580 22
Report on yellow-fever epidemic of 1878	.....	1,800 00	.....	.....
Hudson County (New Jersey) investigation	.....	1,000 00	.....	.....
Purchase of tents, furniture, &c., for stations	.....	9,297 41	485 45	.....
Aid to State board of health, Tennessee	.....	36,292 44	.....	.....
Aid to State board of health, Illinois	.....	1,323 32	.....	.....
Aid to State board of health, Mississippi	.....	7,026 64	.....	.....
Aid to State board of health, Arkansas	.....	6,399 76	.....	.....
Aid to board of health, Mobile, Ala	.....	2,195 46	.....	.....
Aid to board of health, Meridien, Miss	.....	218 30	.....	.....
Aid to District of Columbia	.....	7,710 00	.....	4,656 06
Immigrant-inspection service	.....	.....	.....	3,168 18
Totals	9,146 41	266,762 16	167,681 95	*98,523 07

* This sum is subject to increase to meet obligations authorized prior to August 6, 1882, to which date the appropriations for the last fiscal year were extended. Estimated amount required, $35,000.

NOTE.—Total appropriations for National Board of Health	$700,000 00
Total expenditures as per statement	542,113 59
Balance unexpended June 30, 1882	157,886 41

It will be observed that the annual expenses for "pay and expenses of members of the Board," on which there was no limitation until the appropriation for the current year, when the sum of $10,000 was allowed by the sundry civil appropriation bill as finally adopted, have never, except once, exceeded that amount, a fact which is not consistent with either the general charge of extravagance or the specific ascription of mercenary motives to the members of the Board. The single exception occurred during the first year, including the epidemic summer of 1879, when two members of the Board were constantly on duty at the places at which the epidemic prevailed, and two others were for a considerable time in active service in directing measures for the protection of the Mississippi Valley. These expenses might very appropriately have been classed among the special appropriations in aid of the places where the service was rendered, and if they had been so charged the remaining expenses, to be placed under the head of pay and expenses of members of the Board, would not have exceeded the average of other years.

It will also be observed that the largest amount ever expended in one year for special scientific investigations, for which the National Academy of Sciences had recommended that no limit under that of $30,000 should be assigned, was $14,496.59.

It will further be observed that for two years in succession a contingent appropriation of $100,000 was made, to be available in the event of an outbreak of epidemic disease, and that not a cent of it was touched in either year. During both years yellow fever existed at Key West,

and it was competent for the Board to open the fund in question for combating the disease at that place and for preventing its transmission to other parts of the United States.

The reasons which induced the Board to abstain from making, by means of the contingent appropriation, the large pecuniary outlay which would have been necessary to establish quarantine inspections and enforce quarantine regulations have been stated in the Second Annual Report for 1880.

During the fiscal year ending August 7, 1882, small-pox prevailed as an epidemic in various parts of the United States, as has been stated in the preceding pages; and in anticipation of the necessity of using the contingent fund, an account was opened with that fund on the books of the Treasury, but by strict economy it was found that the expenses of the immigrant inspection service could be met during the remainder of the fiscal year out of the general fund, and thus no portion of the contingent appropriation was touched.

ESTIMATES.

Having shown that the charges preferred against the Board on the grounds of alleged extravagance and usurpation of authority not conferred upon it by law are not sustained by the record, but that on the contrary the expenditures have been on a scale of extraordinary economy in comparison with the magnitude of the useful work accomplished, and that this work of every kind fell clearly and unmistakably within the limits of its discretion, the National Board considers it its duty again to recommend the granting by Congress of such an appropriation at the ensuing session of Congress as will put it in its power to execute the law which defines its powers and prescribes its duties, to the end of conserving the public health and of preventing the introduction of contagious or infectious diseases into the maritime ports of the country and their transmission along the trunk lines of railway into the interior States.

The following estimates for the year ending June 30, 1884, are therefore respectfully submitted:

For aid to State and local boards of health:	
By the maintenance of a refuge station at Ship Island, Mississippi	$18,000
By the maintenance of a refuge station at Sapelo Sound, Georgia	15,000
By the maintenance of a hospital barge at Hampton Roads, Virginia	2,500
By the maintenance of the inspection service on the Mississippi River	25,000
By the maintenance of the immigrant inspection service	30,000
By the maintenance of inspections at foreign ports	8,000
For miscellaneous investigations under the constituting act March 3, 1879	10,000
For pay and expenses of the members of the Board	7,000
For compiling and printing the Bulletin and for miscellaneous printing	15,000
For pay of secretary, notwithstanding the provisions of sections 1763, 64, and 65, Revised Statutes, of which sum $600 shall be immediately available	1,800
For pay of disbursing agent, clerks, messengers, and laborers	13,500
For rent, light, and fuel, telegrams and postage	2,200
For stationery and furniture	1,500
For incidental expenses	500
Total	150,000
For aid to local quarantine stations and for aid to local and State boards of health, to be used in case of epidemic	$100,000

JAS. L. CABELL,
President National Board of Health.
CH. SMART, *Major and Surgeon, U. S. A.,*
Secretary National Board of Health.

Hon. C. J. FOLGER,
Secretary of the Treasury.

APPENDICES.

REPORTS AND PAPERS.

APPENDIX A.

MEMOIR ON THE NATURE OF DIPHTHERIA.

By Drs. H. C. Wood and H. F. Formad, of Philadelphia, Pa.

PREFACE.

The research of which the present memoir is the outcome was originally undertaken at the instance of the National Board of Health, and has been prosecuted under their auspices. In detailing and discussing the results we have divided the subject into several chapters, more or less arbitrarily it may be thought, but yet, as we trust, in manner to add to the completeness and perspicacity of the memoir.

University of Pennsylvania, *October* 1, 1882.

CHAPTER I.

ON THE STRUCTURE OF THE DIPHTHERITIC MEMBRANE.

Experimental studies made upon the lower animals and careful histological studies of the morbid process as it occurs in the human subject have convinced us that a

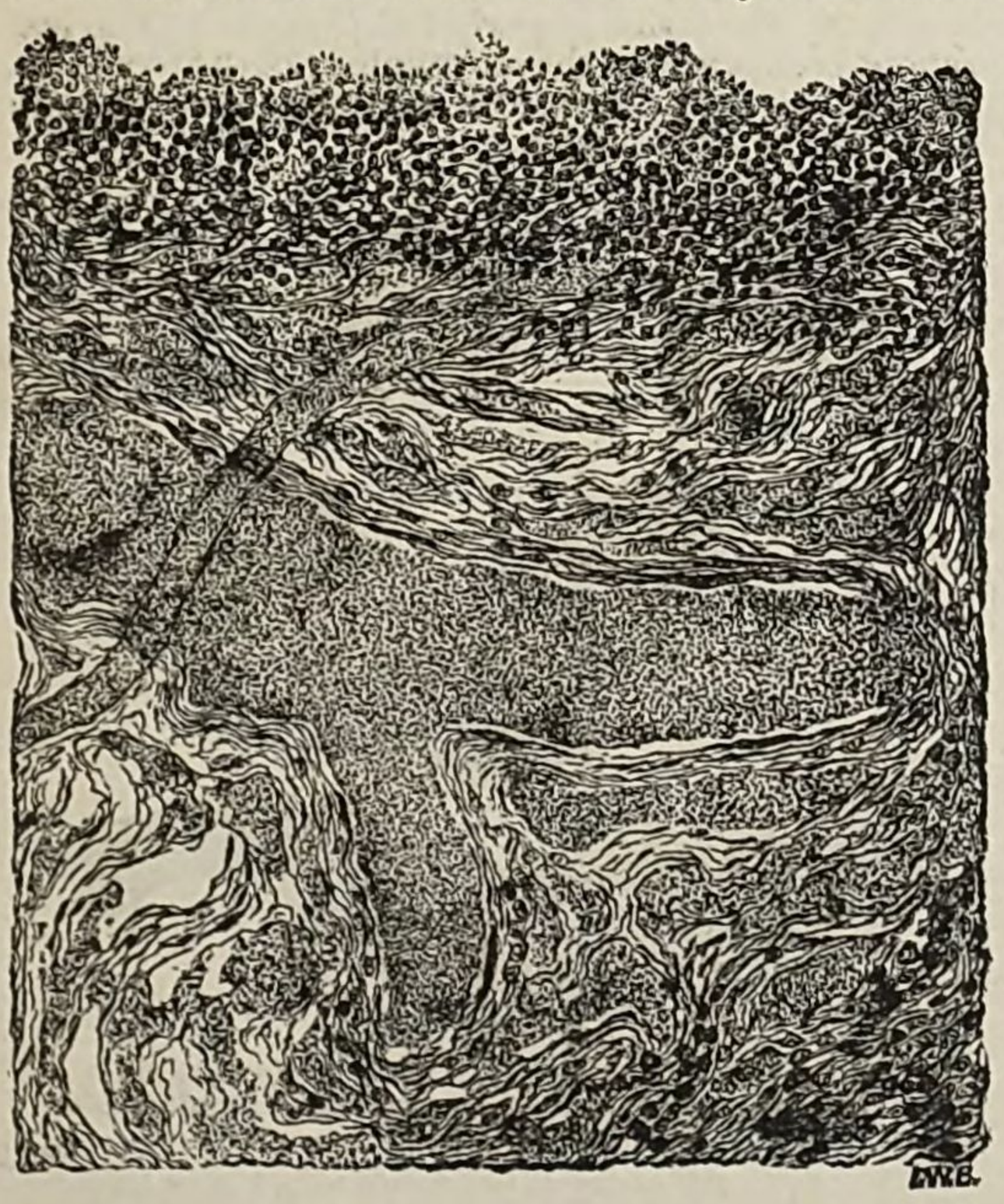

Fig. 1.—Transverse section through the floor of a diphtheritic ulcer of pharynx of child, representing submucous tissue with blood vessels and lymph-spaces filled with micrococci. Part of the necrotic mucosa is seen in upper portion, the bulk of it having been removed together with the pseudo-membrane. Magnified 250.

pseudo-membrane has a similar constitution in whatever part of the body it may have been formed, and whatever may have been the cause of the inflammation which gave rise to it. The slight differences which exist are due to the various structure of the parts affected, to the degree of the inflammatory process, and to the opportunity which has been afforded for the development of microscopic organisms. In the present chapter we will therefore not employ the terms diphtheritic and croupous membranes, but pseudo-membranous exudates, which, it is to be rembered, may be situated superficially upon a membrane or part, or may be deep seated in a tissue. Many clinicians consider

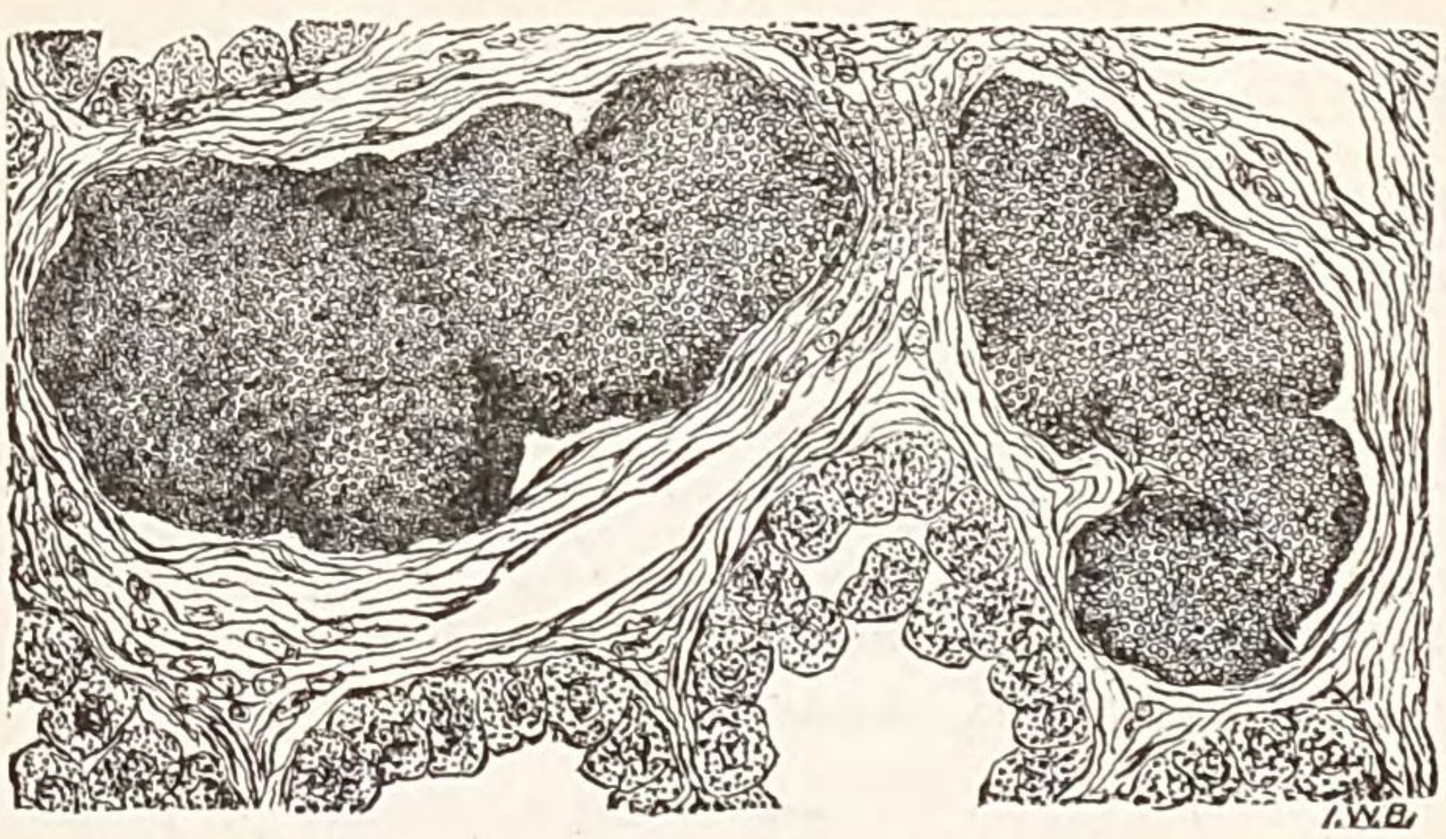

FIG. 2.—A micrococcus-embolus obliterating a small vein in kidney, from case of diphtheria in child See case 5. Magnified 500.

diphtheria and pseudo-membranous croup to be distinct diseases. The discussion of this question must be postponed until the latter part of this memoir, : at present we are only concerned with the anatomical point of view, i. e. with the structural characters, and with the relations of the exudates.

It is easy to demonstrate that the apparent difference in the lesions of diphtheria and pseudo-membranous croup, and in the morphology of the exudates, is partly dependent upon the anatomical peculiarities of the pharynx and respiratory passages, and partly upon the degree of the inflamation.

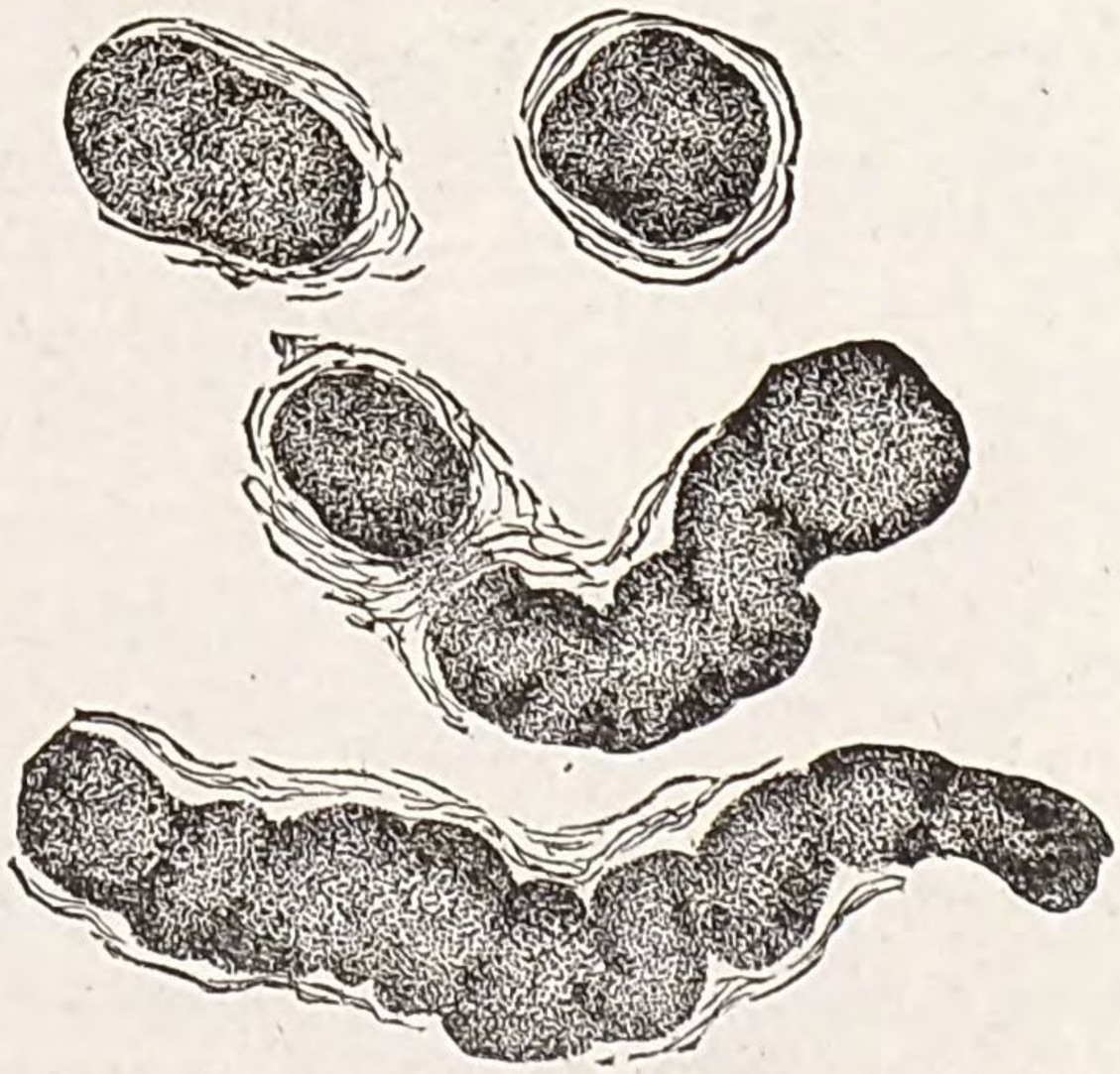

FIG. 3.—Transverse and longitudinal view of micrococcus-emboli from kidney. See case 22. Magnified 300.

The submucous tissue of the pharynx is made up of a loose, highly vascular connective tissue, which does not restrict the congestion of the vessels and the extravasation of the corpuscular elements. At the same time the rapidly coagulable exudate only partly reaches the surface of the mucous membrane, the bulk of it being kept below by the heavy layer of stratified epithelium.

The submucous tissue of the trachea, on the other hand, is made up of a dense elastic tissue and of an only slightly vascular cellular tissue, backed by the avascular

cartilaginous rings. Hyperæmia and extravasations from the vessel are here limited, and only severe inflammation will give rise to exudates, which, when produced are rapidly expelled by the dense matrix, and, meeting with no resistance on the part of the single-layered epithelial covering, coagulate mostly on the surface.

Again, the mucous membrane of the fauces and mouth has a squamous not easily detached epithelium, and consequently membrane connected with or springing from such surface is firmly adherent. The epithelium of the trachea is columnar, ciliated, and detaches with the utmost facility even in normal conditions of the organ; hence exudate attached to it separates readily. The exudate of diphtheritic trachitis is always readily detached in the line of the epithelium. The detachment is, according to Rindfleisch, further facilitated by the excessive secretion of the tracheal glands, the liquid forcing itself between the mucous surface and the pseudo-membranous exudate.

Another distinguishing point made by authors between the pharyngeal and tracheal lesions in question is the independence of their individual occurrence, it being asserted that, if a real malignant diphtheritic trachitis occurs, it is only by extension from the pharynx downwards into the air passages. It is true that diphtheria usually begins in the fauces, but we have observed in several instances the reverse to have taken place; and in two of our rabbits in which an artificial pseudo-membranous trachitis was induced the disease extended also upwards, producing a secondary most violent pseudo-membranous angina.

As an important difference between diphtheritic and inflammatory croup, and between diphtheria and the so-called true croup, some authorities insist upon the presence of micrococci in one and their absence in the other affection.

This is, however, an error. We have never been able to produce artificially in the animal or to obtain from the human subject a membrane free from micrococci, although under some circumstances the micrococci are very much fewer than in ordinary diptheritic exudate.

The frequent absence of the systemic disturbances in the local affections of the air passages can likewise also be explained by the anatomical peculiarities of the trachea and larynx; the dense unyielding subcutaneous and cartilageous tissues of these parts, their deficiency in blood vessels, and imperfect connection with the lymphatic apparatus, prevent in a great measure the absorption into the system of the necrotic products, so that either recovery or death from stenosis usually takes place before a systemic infection ensues. In some instances in which the tracheal affection has lasted long enough, we have seen distinct systemic infection manifested by the symptoms and evident from the presence of micrococci in the blood.

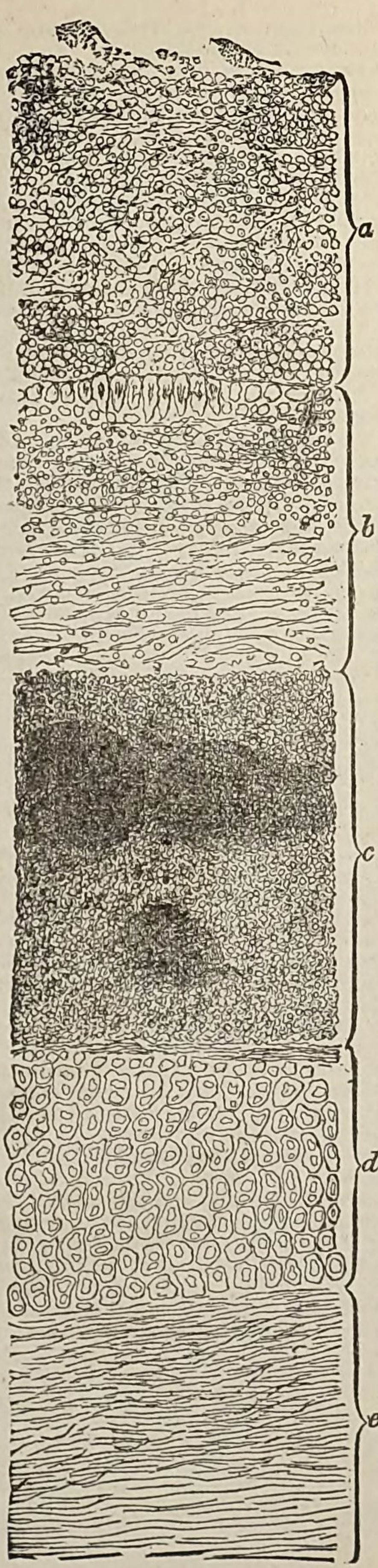

FIG. 4.—Transverse sect'on of trachea with artificially-produced (by ammonia) pseudo-membrane. Magnified 250 diameters. *a*. Superficial psendo-membrane. *b*. Croupous exudate below basement membrane. *c*. Ecchymosis in submucons-tissue and infiltration of tracheal glands with blood corpuscles. Between *a* and *b* are seen some remains of surface epithelium. *d*. Cartilage. *e*. Outer connecting tissue and muscular investment.

A subdivision of membranous croup into a diphtheritic and inflammatory variety is anatomically not justifiable.

We have observed that the exudation on the trachea, even in the simplest inflammatory croup, is met with not only on top of the epithelium, but also below the latter, precisely as in true diphtheritic angina, only in a slighter degree.

Our preparations show that the exudation of the croupous inflammation excited artificially in the trachea is not merely superficial, but also extends below the basement membrane, as illustrated in Fig. 4.

In cases of artificial croup as well as in those observed in man, in which the *submucous* infiltration is prominent, we have seen loss of substance, viz, necrotic ulcerations similar to those occurring in genuine diphtheritic angina.

It would seem therefore that there are no specific anatomical characters in the diphtheritic exudate which separate it from other acute false membranes; also that micrococci are always abundant in the exudate, usually forming a great part of its bulk.

The microscopic picture obtained from our sections, made perpendicularly through diphtheritic ulcers, show that simple inflammatory changes are the initial step in the local diphtheritic process. This is also in accordance with the description of all reliable observers.

All the peripheral layers of the part affected are seen to be intensely infiltrated by the pseudo-membranous exudate, all the blood vessels are obliterated, and life and nutrition of the part nearly ceases. The tissue undergoes fatty degeneration, and hence is quite easily penetrated by the micrococci on the surface. This produces a condition histologically not unlike gangrene and probably identical with it. The micrococci advance from the periphery inwardly to enter the lymph-spaces opened through destruction of the connective tissue. Once having entered the lymph-spaces, the micrococci are not seen to produce any histological changes in the surrounding deeper tissues. They next enter the blood vessels. While all the lymph-spaces are overdistended with micrococci, the blood vessels can be frequently observed to be empty side by side with the lymph-spaces. In other places a gradual filling of the blood vessels (veins chiefly) with micrococci is seen. This evidently proves that the micrococci enter the blood through the medium of the lymph-spaces.

The drawings which we append show the way in which the micrococci enter the system. We have endeavored to make photographic illustrations, but found it impossible to bring out the structure satisfactorily. The cuts are photographic reproductions of very accurate and careful camera-lucida drawings.

Fig. 1 represents a perpendicular section through the floor of a diphtheritic ulcer of pharynx of child (age three years) who died on the seventh day of the disease (see Case No. 5 in tables). The false membrane proper had nearly altogether sloughed away and the rest of the exudate become detached during the preparation of the section, leaving the bare submucous tissue. A vein running parallel to the surface is seen completely blocked up by micrococci. The latter crowd also all the lymph-spaces of the connective tissues everywhere. A small capillary blood-vessel crossing the vein at nearly right angles is also seen to be filled by micrococci. The upper portion of the drawing represents gradually advancing necrotic change of the peripheral granulation tissue.

Figs. 2 and 3 represent camera-lucida drawing of micrococci emboli from kidneys. These emboli will be often referred to in the tables and text of this monograph.

For the sake of comparison we print here Fig. 4, which shows a narrow strip of a transverse section of trachea with artificially-produced (by ammonia) pseudo-membrane in rabbit. The exudate is seen both above and below the epithelium and basement membrane.

The results which have been arrived at in this chapter may be summed up in conclusion, briefly as follows: First. No anatomical essential differences exist between diphtheria and croup; the apparent differences being conditioned by the location of the exudate. Second. Micrococci are always present in the local diphtheritic exudate. Third. If the local diseased process goes far enough, the micrococci force their way through the lymph-spaces, opened by the necrosis, into the veins and finally into the blood. The obvious conclusion is that whilst the clinico-pathological evidence does not prove that the micrococci are essential to diphtheria, it leads towards such a view, and at least shows that some close connection exists between these organisms and the disease.

CHAPTER II.

ON THE CLINICAL RELATIONS OF MICROCOCCI TO DIPHTHERIA.

Having found that the micrococci are an essential part of the diphtheritic membrane, the important question presents itself as to whether the micrococci found in the diphtheritic lesions are identical in form and size with those which are present not only in the membrane of a non-diphtheritic trachitis, but also in the exudation of an inflamed tonsil? We do not hesitate in affirming that it is not possible to determine, even with the highest powers of the microscope, whether an individual micrococcus colony or mass of such colonies have come from the surface of a furred tongue, or from an ordinary case of simple throat inflammation, or from one of a diphtheritic character. As evidence of this we offer the following microphotographs, Fig. 5 taken from an undoubted case of diphtheria, Fig. 6 from an ordinary tongue scraping.

FIG. 5.—Micrococci from blood in diphtheria × 1,000.

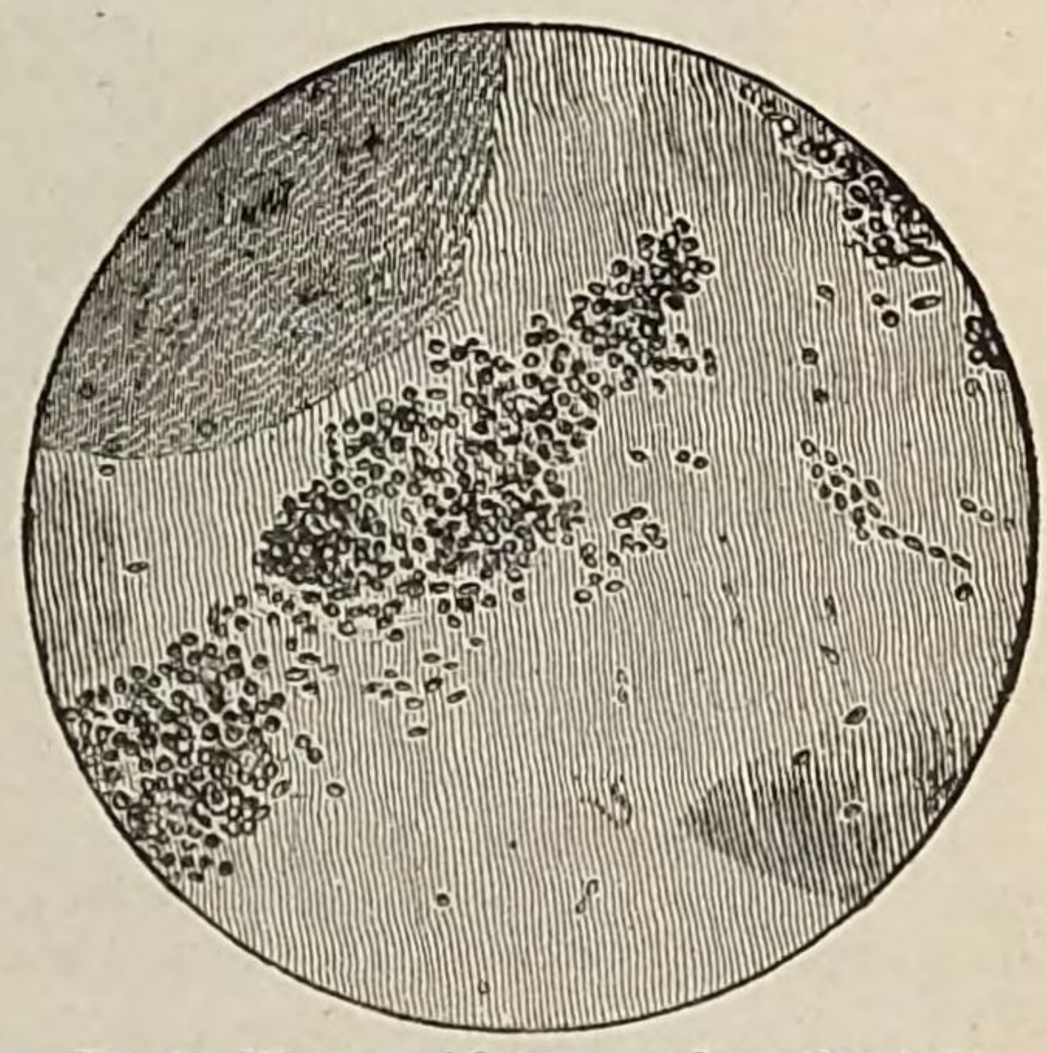

FIG. 6.—Micrococci from normal mouth × 1,000.

A second question, no less important than that just discussed, is, Are the micrococci present always in the blood of persons having diphtheria, or only in some cases? The vital nature of this query scarcely requires pointing out. If micrococci are really always to be found in the disease it is very probable that they are at least an essential part of it; on the other hand, if they are only occasionally present it is probable that they are an accident of the affection.

In attempting to answer the question just propounded we have examined a large number of cases. Without further discussion, we desire once for all to state that every precaution has been taken to make the examinations at once careful and exhaustive.

The cases examined are naturally divided into two sets, according to their geographical and epidemic relations. One of these sets (No. 1) represents what we may be allowed to call endemic or sporadic diphtheria. The other series (No. 2) illustrates true malignant epidemic diphtheria. In the city of Philadelphia there are always more or less numerous cases of the disease of varying type as to severity, but at no time during our studies has there been anything which could properly be termed an epidemic of diphtheria. Cases of set No. 1 were all observed in Philadelphia or its vicinity.

The town of Ludington, situated on Pere Marquette Lake, upon the east shore of Lake Michigan, in the State of Michigan, is a center for the lumber trade, and an enormous amount of sawdust is annually produced there. A part of the town is situated upon a high plateau, but the third ward, bordering upon the lake, is built upon a swamp, which has been filled largely with the great staple of the place—*i. e.*, sawdust. The drainage is so bad that in many places a hole dug a couple of feet in the ground soon fills with water, and only in a small percentage of the houses has any attempt been made to construct cellars. During the winter of 1880 and 1881 diphtheria appeared in this low region and spread with such thoroughness that it is said scarcely a child escaped an attack, and about one-third of them died. Dr. Formad was sent in the month of June to Ludington, and made studies there of the disease, with espe-

cial reference to the micrococcus question. In the spring of 1882, Dr. Formad went to Lakeview, in the center of Michigan, to study an epidemic at that place.

The blood examinations during life were made directly at the bedside. They were all purely microscopical, and attention was especially directed to the presence or absence of micrococci, and, when they were found, to their mode of grouping, &c.

FIG. 7.—Micrococci in blood from diphtheria × 1,000, showing a zooglæa mass.

In all cases the blood was taken from the finger with due precaution as to cleanliness. Uniformity of method was strictly observed in the examinations. In doubtful cases caustic potash, glacial acetic acid and aniline dyes were used as tests for micrococci.

As a rule in all fatal and in many favorable cases the quantity of the white blood corpuscles was found increased; the average proportion of white to red was frequently

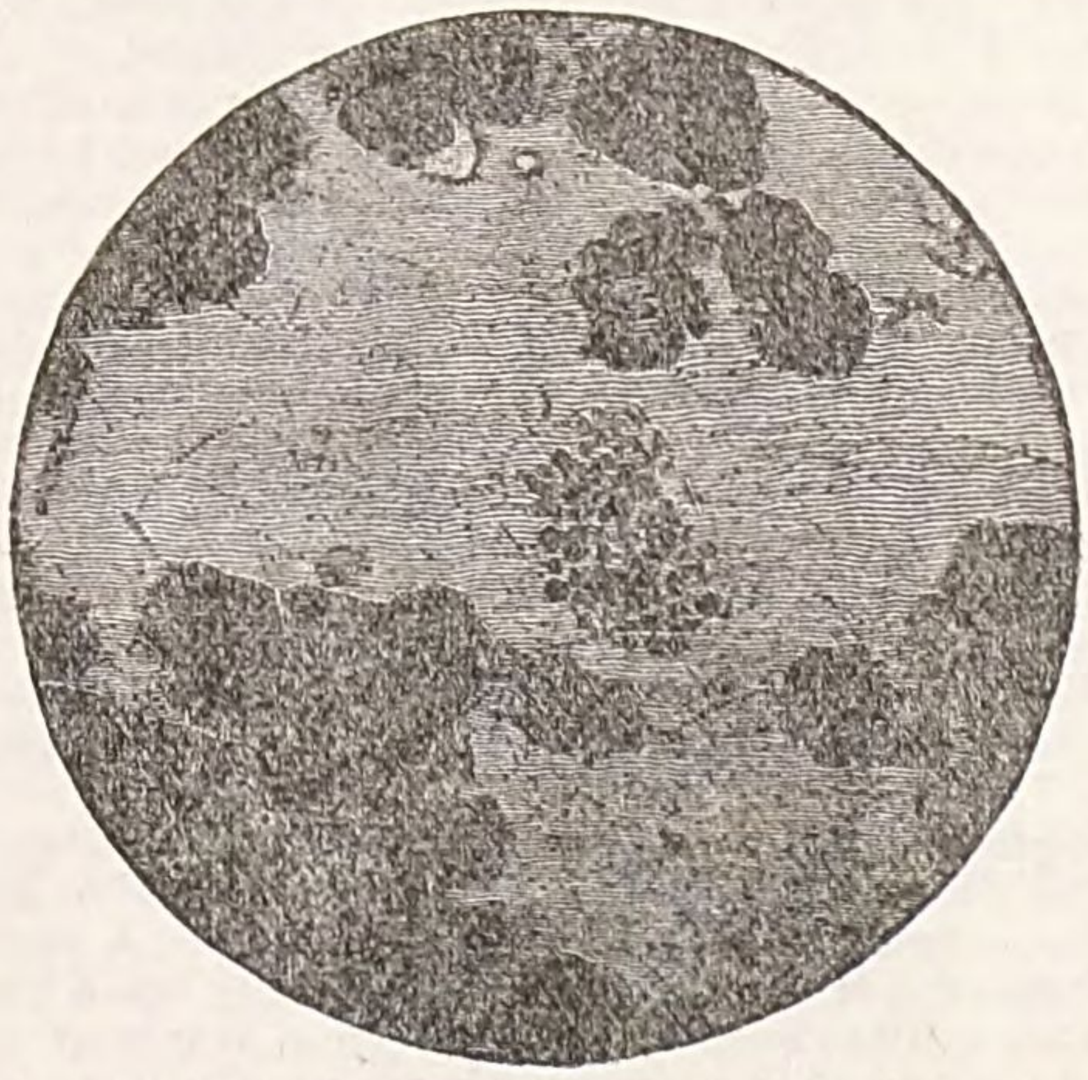

FIG. 8.—Micrococci in blood from diphtheria × 1,000, showing a zooglæa mass.

about one to fifty and occasionally one to twenty. Great irregularity in size and coarser granulation than normal of the protoplasm of the corpuscles was observed in all bad

cases and only rarely in favorable ones. A peculiar appearance of the white blood corpuscle was also observed, which we will call "loculated." Such white corpuscles contained vacuoles usually intercepted by delicate partitions, and were usually irregular, lobulated, enlarged, and as a rule contained a few to many micrococci.

Nearly all cases of diphtheria in which these modified white blood corpuscles were observed terminated fatally, and all such cases showed large quantities of micrococci in the blood. Sometimes these corpuscles appeared, as it were, ruptured and zoogloea-masses of micrococci were seen alongside or in their immediate vicinity. The red blood corpuscles very seldom form rouleaux in diphtheritic blood, appearing also paler and apparently losing their bi-concavity. They are never affected by micrococci. Precipitation of fibrin is unusually well marked in the blood from diphtheritic cases.

For the opportunity of examining the cases, particular thanks must be tendered to Drs. Lamareau and Adams, of Lakeview, Mich., and to several physicians of Philadelphia, especially to Dr. Jno. M. Keating, of the Philadelphia hospital.

The reproductions of the microphotographs in this paper are not successful, and do not fairly represent the originals sent with the report. The original microphotographs were executed in our laboratory by Dr. William Gray.

No. 1.—*Cases of diphtheria studied in Philadelphia.*

No. of case.	Sex.	Age.	Day of disease.	Condition of blood, quantity and character of micrococci.	Quality and condition of white blood corpuscles.	Condition of patient at the time of examination and termination of disease.	Remarks.
1	Male....	3 years..	.....	Blood did not show micrococci during life.	.....	Died on fifth day..	*Autopsy.*—Blood taken by sealed glass tubes from jugular vein eighteen hours after death contained micrococci; organs not examined; false membrane from larynx used for culture. Last examination of blood was two hours before death. Died from laryngeal stenosis.
2	....do ...	6 years..	Fifth day.....	No micrococci found during life; blood examined on sixth and eighth day, with the same result.	Normal	Condition of patient bad, but chiefly from local symptoms. Died on eighth day.	*Autopsy, thirty hours after death.*—Blood taken from jugular by means of sealed tubes contained micrococci both in masses and attacking the white blood cells. Rigor mortis not marked; no signs of decomposition. Face and neck were of dark-bluish hue. All the veins of the neck were enormously distended by very dark blood. Salivary and cervical lymphatic glands strongly congested and somewhat enlarged. Larynx and trachea were almost completely obstructed by casts of false membrane, which extended into many of the bronchi. The mucous membrane of the upper anterior portion of the trachea showed several shallow necrotic ulcerations. The vocal cords were thickly covered with closely-adherent pseudo-membrane. Lungs congested and œdematous; several hemorrhagic infarctions at the periphery of lower lobes. Pericardium and pleura congested. Heart: Right side filled with large ante-mortem clots, extending into pulmonary artery and its ramifications; orifices and endocardium normal. Liver, kidneys, and spleen strongly congested; microscopic examination did not show any other lesion than cloudy swelling, and proved absence of micrococci. Stomach empty, and, like the intestines, was much distended by gases; the mucous membrane of both congested. Other abdominal viscera normal. Examination of tongue, pharynx, and brain was not permitted.

3	Male ...	11 mos ..	Third day	The blood showed abundant micrococci in large loculated vesicles, about twice the size of white blood corpuscles, out of which they were apparently formed.	White blood corpuscles increased in number.	Child very ill	Admitted to the Philadelphia Hospital July 7, with considerable membrane in the pharynx, and marked febrile disturbance.
			Fourth day	Blood as on the third day...	.....	.....	
			Eighth day	Very few micrococci.....	Normal	Child better.	
			Tenth day.....	No micrococci	.....do	Convalescent.	
4	Male ...	9 mos ...	Seventh day.....	.....do	.....do	Died eighth day ..	Died from laryngeal stenosis; no autopsy allowed.
5	Female .	3½ years.	Fifth day.....	Micrococci in great quantity, both free and infesting white blood corpuscles.	White blood corpuscles greatly increased in number.	Bad.....	Pseudo-membrane covering pharynx and extending into nasal passage. There was no other case of diphtheria anywhere in that neighborhood.
			Seventh day.....	Micrococci in enormous quantity, free and in zooglæa masses.	White blood corpuscles very numerous, infested by micrococci and loculated.	Worse.	
			Eighth day	Blood highly coagulable....	.....	Died in evening of the eighth day.	Autopsy made in this case ten hours after death. Blood from heart showing apparently a smaller quantity of micrococci than examination from tip of finger during life; also fewer white blood corpuscles, though all loculated. Veins of neck enormously overfilled with blood; lymphatic glands and tonsils greatly enlarged. Heart congested. Large ante-mortem clot in right side of heart, with thrombi extending into pulmonary vessels. Base of both lungs congested. Abdominal organs all congested. Kidneys enlarged and lobulated; the latter condition was probably congenital, as no structural changes could be discovered, save a slight catarrhal condition. Micrococci thrombi, obstructing many of the capillaries and small veins of kidneys; also numerous micrococc masses were seen, in smaller and larger vessels of liver, spleen, thyroid, lymphatic glands, and heart muscles. In all these last-named organs the micrococci were not as distinct thrombi. Inoculations of animals with membrane from this case nearly all proved fatal.
6	Male....	3 years..	First day	No micrococci	Blood normal	Bad sore throat; no fever.	The child was born and nursed in the colored obstetric ward; no other case was known to have occurred within month.
			Second day	.....do	Some increase of white blood corpuscles; blood otherwise normal.	Worse.	
			Third day	Micrococci in blood free and in zooglaed masses in enormous quantity; also affecting white blood corpuscles.	White blood corpuscles in great excess, and many loculated.	Very bad; croupous symptoms; worse.	Heavy pseudo-membrane extending into nasal passages.
			Fourth day.....	Same as yesterday	The same	.....	

No. 1.—*Cases of diphtheria studied in Philadelphia*—Continued.

No. of case.	Sex.	Age.	Day of disease.	Condition of blood, quantity and character of micrococci.	Quality and conditions of white blood corpuscles.	Condition of patient at the time of examination and termination of disease.	Remarks.
			Sixth day			Died early in the morning.	*Autopsy, soon after death.*—Micrococci abundant in blood from jugular vein, although less so than during life. There were also some rod-bacteria. Neck greatly swollen from venous congestion and enlargement of all glands. Large ante-mortem clots in heart, containing quantities of micrococci. Internal organs all congested, but the most exhaustive examination did not reveal any micrococci.
7	Female	11 years.	Third day	No micrococci	Blood normal	Favorable	Throat not very bad.
			Fifth day	do	Some increase of white blood corpuscles.	do	Reported as recovered.
8	do	5 years.	Second day	do	Blood normal	Bad case	Very extensive pseudo-membrane.
			Fourth day	Micrococci in blood free, and also in white blood corpuscles.	White blood corpuscles loculated.	Worse	
			Eighth day			Died	There was no more chance for further examination of blood. No autopsy.
9	Male	7 years.	Fourth day	No micrococci	Blood normal, but highly coagulable.	Favorable	
10	Female	2 years.	Second day	do	Blood normal	do	
			Fifth day	Micrococci in blood, but not affecting the white blood corpuscles.	Decided increase in white blood.	Condition worse	
			Seventh day	Same as before		Apparently improving.	Patient got well.
11	do	3 years.	Fourth day	No micrococci	White blood corpuscles increased in quantity.	Quite a bad case	Two children had died before in the same family of diphtheria within two weeks.
			Sixth day			Utimately recovered.	
12	Male	5 years.	First day	do	Blood normal	Tonsils covered, otherwise well.	
			Second day	do	do	Worse	
			Third day	Some micrococci free, but not in white blood corpuscles.	White blood corpuscles increased in number.	Conditions favorable.	
			Fourth day	Abundant quantity of micrococci.	White blood corpuscles increased, also some few loculated.	Conditions favorable.	No false membrane could be obtained from this case; there was very little of it at any time.
			Fifth day	Micrococci less abundant		Improving	
			Seventh day	Very few micrococci now in the white blood corpuscles.	Blood normal	do	

			Tenth day				Reported well.
13	..do	1½ years	Second day	Some few micrococci in blood, none in white blood corpuscles.	Excess of white blood corpuscles.	Tonsils covered, otherwise well.	False membrane disappeared under treatment.
			Fourth day	None	....do	Conditions good ..	Recovered.
14	Female .	3 years ..	Third day	No micrococci	White blood corpuscles increased.	Bad	Disease had commenced with croup false membrane extended into pharynx and to tonsils.
			Fifth day	Some few micrococci in white blood corpuscles.	....do	Very bad	
			Sixth day			Died mainly of croup.	No autopsy.
15	Male	..do		Blood examined three times, no micrococci.	Normal	Recovered	Local affection of throat very slight in all these cases.
16	...do	2 years ..		Blood examined twice, no micrococci.	....do	.. do	
17	Female .	10 mos ..		Blood examined once, no micrococci.	....do	....do	
18	...do	1½ years.		Blood examined four times, no micrococci.	....do	... do	
19	...do	1 year...		Blood examined twice, no micrococci.	....do	....do	
20	Male....	2 years ..		Blood examined four times, no micrococci.	....do	....do	
21	...do	2 years ..		Blood examined twice, no micrococci.	....do	....do	

No. 2.—*Cases of epidemic diphtheria studied in Ludington, Mich.*

No. of case.	Sex.	Age.	Day of disease.	Condition of blood, quantity and character of micrococci.	Quantity and conditions of white blood corpuscles.	Condition of patient at time of examination and termination of disease.	Remarks.
22	Male....	5 years..	Second day ...	Moderate quantity of micrococci, a few in white blood corpuscles.	.....	Bad.....	Half an hour before death blood was taken from the finger (which was very cold); it was dark, coagulated almost instantly, and offered but few micrococci. It was then taken from the thigh, where the temperature was still high, and was found to be gorged with micrococci. *Autopsy twelve hours after death.*—Body of livid appearance; no rigor mortis; no fetid odor; no signs of decomposition. Brain: Sinuses filled with very dark blood containing enormous quantity of micrococci. (It was taken by sealed glass tubes before opening of vessel.) All the blood vessels of the brain and its membranes congested; other changes were not notable by naked eye nor by microscope. There was some increase of fluid in the lateral ventricles. The medulla oblongata and a small portion of the cord which was removed through the occipital foramen did not show any morbid changes. Neck: Lymphatic and salivary glands enlarged and highly congested. All the large veins highly distended. Blood similar to that found in sinuses of brain. Tongue removed from below, intact with the tonsils, pharynx, larynx, and trachea. The mucous membrane of all these parts was covered with moderate sized patches of pseudo-membrane, which, in some places, appeared raised over the surface, in others, showed shallow necrotic ulcerations. The same was observed upon the vocal cords and the nasal mucous membrane. In the trachea the exudation was slight, most marked at the bifurcation, and of darker color than in other parts. Lungs: Congested, with slight hemorrhagic infarctions in lower lobes; a few of the bronchi contained casts of the exudate Heart: Pericardial fluid increased; heart muscle congested; otherwise normal; right side
			Third day.....	Micrococci more abundant, many in white blood corpuscles.	.....	Worse.	
			Fourth day.....	Masses of micrococci everywhere in blood, almost all white blood corpuscles affected.	.....	Do.	
			Fifth day.....	Very dark, and full of micrococci, none observed in white blood corpuscles.	.....	Died.	

							contained large, white, firm clots extending into pulmonary vessels; in left side only red clotted blood. Mycotic erosions were seen upon endocardium below the pulmonary and the aortic valves. Mediastinal and bronchial glands were enlarged and congested. Liver enlarged and extremely congested; gall bladder very much distended with very dark bile. Spleen normal size, rather hard in consistence, and showing congestion and hemorrhages. Stomach showed a few hemorrhagic erosions, and contained only a few drachms of a dark semi-liquid matter. The intestines, although of dark hue, appeared normal. Kidneys were enlarged, strongly congested, and presented the appearance of acute parenchymatous nephritis. This was confirmed by microscopic examination, which revealed also micrococci emboli in the blood vessels of these organs. The bone marrow, taken from a rib, as well as the parenchyma of the spleen, was infested by micrococci. Rest of organs normal. The urinary bladder was found empty.
23	Female..	2 years..	Fifth to tenth day.	Micrococci in blood varying from day to day, as patient was better or worse.	.....	Died.....	Died on tenth day. No autopsy.
24	Male....	7 years..	.....	.....	.....	Recovered.....	Blood examined three days and micrococci found.
25	Female..	3 years..	Fifth day.....	Moderately abundant micrococci.	.....	.....	Child convalescent at time of examination.
26	Female.	4 years..	Eighth day.....	None.....	.....	.....	
27	Male....	5 years..	Fifth day.....	Abundant micrococci.....	}	}	All had the mild form of disease; the blood of each was examined once and no micrococci found.
			Sixth day.....	.....do.....			
28	.....	3 years..	.....	No micrococci in blood.....		.....	
29	.....	6 years..	.....	.....do.....			
30	.....	9 years..	.....	.....do.....			
31	.....	12 years..	.....	.....do.....			
32	Female..	4 years..	.....	Moderate quantity of micrococci.	.....	.....	At time of examination recovering from severe attack and still much affected.

No. 2.—*Cases of epidemic diphtheria studied in Lakeview, Mich.*—Continued.

No. of case.	Sex.	Age.	Day of disease.	Condition of blood, quantity and character of micrococci.	Quantity and condition of white blood corpuscles.	Condition of patient at time of examination and termination of disease.	Remarks.
33	Female	11 years.	Fourth day	Micrococci in blood free and in small clouds; very few or no white blood corpuscles affected.	No loculated cells	Bad.	
			Sixth day	Very few micrococci		Improving	The patient was not seen again, but we learned of her complete recovery.
34	Female	10 years.	Fifth day	No micrococci	Normal, only some increase in white blood corpuscles.	Pretty bad.	
			Eighth day	do	Normal	Rapidly improving.	Throat got well and clear, only tonsils swollen. We know the patient to have made good recovery.
35	Male	8 years.	Seventh day	do	do	Recovered.	
36	Male	2 years.	Fifth day	do	do	do	
37	Female	6 years.	Sixth day	Some micrococci in small clouds, but none affecting white blood corpuscles.	Decided increase in white blood corpuscles.	do	Both children in one family. They were quite ill, but recovered. One child had died a few days before in the same family.
38	Male	5 years.	Third day	No micrococci		do	
39	Male	5 years.	Fourth day	Micrococci in blood and loculated cells containing micrococci.	White blood corpuscles in great excess.	Very bad; pronounced hopeless at the time.	Information concerning the exact termination of the case not obtained.
40	Male	4½ years.	Fifth day	No micrococci	Normal	Favorable	Blood was sent to us on slide by the attending physician.
41	Female	5 years.	Second day	do	do	do	Same as last.
42	Female	8 years	Third day	do	do	do	
43	Female	4 years	Fourth day	Large quantity of micrococci in blood.	White blood corpuscles in excess.	Very bad	Termination unknown.
44	Female	12 years.		Micrococci in blood; no loculated cells.	do	Very bad case	Do.
45	Male	2 years.	First day	No micrococci	Normal	High fever; bad case.	Do.
46	Male	4½ years.	Second day	do	do	Apparently bad case.	Do.
47	Female	3 years.	Second day	do	Normal. Some slight excess of white blood corpuscles.	Bad case	Do.
48	Female	20 years.	Third day	Micrococci in large quantity, infesting white blood corpuscles; also free micrococci, and in large isolated clouds or zooglœa masses of unusual size.	Great increase of white blood corpuscles; many loculated.	Bad	

			Fourth day	The same as yesterday	More loculated corpuscles	Somewhat better	In this case there was enormous, rapid development of pseudo-membrane in pharynx, on tongue and on buccal mucous membrane, and extending into nasal passage vigorously, and to some degree into larynx. Temperature at night reaching 103° Fahr.
			Fifth day	Micrococci increasing rapidly in quantity.	White blood corpuscles increasing in quantity, but about one-third of them are loculated, and contain micrococci.	Worse	
			Seventh day	Apparently decided diminution in micrococci.	Fewer white blood corpuscles.	Better	
			Eighth day	Same as last	do	do	
			Ninth day	Micrococci again, in increased quantity, in all forms of grouping.	White blood corpuscles severely attacked by micrococci.	Worse	
			Tenth day	Micrococci seen in large clouds; many also in chains and free.	White blood corpuscles in large quantity, but nearly all loculated and infested with micrococci.	do	In the same family there had been several cases of diphtheria before.
			Thirteenth day			Died	No autopsy.
49	Female.	16 years.	Third day	Blood appears normal	White blood corpuscles infested by micrococci; no loculated white blood corpuscles.	Doing well	Moderate amount of pseudo-membrane upon ulcerated tonsils.
			Fifth day	Large amount of micrococci in blood, but only few in cells.	Great increase in white blood corpuscles; only few loculated.	Very bad	One ounce of pseudo-membrane was removed from pharynx, nose, and tongue, and still much was left.
			Seventh day	Very few micrococci free and in chains, in blood.	Diminution of white blood corpuscles; no loculated cells.	Doing well	
			Ninth day	No micrococci	Blood normal	do	The patient recovered perfectly.

A study of the first of these tables shows that examinations were made of the blood of twenty-one cases of diphtheria in Philadelphia, and that in eleven of these cases no organisms were found at all, whilst in ten cases micrococci were detected in more or less abundance during life or directly after death.

A further study also shows that but one case of the eleven without micrococci died, and that in this case (Case 4) the cause of death was laryngeal stenosis, produced by the local disease, and no autopsy was permitted. The experience in Case 2 shows that it is possible to fail in the detection of micrococci, although they may exist in the blood which is in the central organs, for a very careful examination of the blood in the finger, made by both of us conjointly, did not reveal the existence of micrococci which the autopsy, only thirty-two hours later, showed to be in advanced development in the blood. It is therefore very probable that if an autopsy had been permitted in Case 4 organisms would have been detected. Of the ten cases in which fungal organisms were found six died.

When the epidemic cases are scrutinized it will be perceived that, of the Ludington cases, micrococci were present in six cases and absent in four cases, the latter all very mild and in one family. Case 26 is not considered, as the child was convalescent at the time of examination.

Of the Lakeview cases, in only seven were micrococci found in the blood, whilst in ten cases no micrococci were apparent. In regard to the mortality, we have no knowledge of a fatal termination in more than two cases, but it is very plain that the cases in which no micrococci were present were much less severe than those in which the organisms were detected.

The observations made in Philadelphia, Ludington, and Lakeview are therefore in accord. In each instance, the cases in which there were no micrococci were nearly all of them light or in the stage of convalescence, and the amount of the fungi present in the malignant cases seemed to be proportionate to the severity of the constitutional symptoms, and to steadily progress with the disease in the fatal cases.

The study of these cases is sufficient to enable us to formulate as established the proposition that *in the endemic diphtheria micrococci are always present in the part locally diseased, but are usually not present during life in the blood or in the glandular organs, even in cases which prove fatal from the interferenee with the breathing by the local disease;* that in *epidemic diphtheria micrococci are always present in the part locally diseased, and are also usually, and perhaps always, to be found in the blood and tissues of severe cases with marked constitutional symptoms, but are frequently, if not usually, absent from the blood of mild cases;* that *the difference is in degree, not kind, as the micrococci are usually present in the blood of malignant cases, whether of endemic or epidemic origin.*

At first thought this proposition might be considered to prove that bacteria are not an essential but an accidental phenomenon of diphtheria. We think, however, that this is hardly a warranted deduction. The micrococci are always present in the throat, and are probably also always present when very marked constitutional symptoms occur. It must be borne in mind that the distinction we have made between epidemic and endemic diphtheria is a purely arbitrary one, for convenience, and in either instance the disease may be mild or malignant, and that in the two classes of cases the symptoms are precisely parallel and the result identical.

CHAPTER III.

THE NATURAL HISTORY OF MICROCOCCI.

In the present chapter we propose to discuss the methods of recognition of micrococci, their life-history within the body, and the methods and results of their culture.

I.—Morphology of the Micrococci.

A.—*Recognition of micrococci.*

Great difficulty is sometimes encountered in distinguishing bacteria from other minute organic and inorganic particles. Certain mycelial threads and vibrios, coagulated fibrin, and protoplasmic and fat molecules often closely resemble micrococci.

As this is a question of importance, we will briefly enumerate the various methods which we have employed and found serviceable in the recognition of micrococci.

In zooglæa forms the micrococci can be distinguished at one glance by an experienced eye, as the micrococci of an individual zooglæa mass are always uniformly of one size and are always at the same distance from one another, in contradistinction to albuminous and fat molecules, which vary in size and are at varying distances from one another.

Isolated micrococci may vary in size, as may also the micrococci in the different zooglæa groups, some of the latter being made up of smaller and others of larger micrococci.

Micrococci may arrange themselves in pairs and in chains; non-living molecules or granules cannot.

Micrococci are not soluble in strong acids and alkalies, nor in alcohol and ether, as are fat and most other molecules.

Micrococci take the staining well, particularly with hæmotoxylin and aniline dyes, and the aniline dye cannot so easily be washed out as in the case of animal tissues. For this reason sections of tissues may readily be prepared in which only the bacteria are stained. Beautiful preparations may also be made by simply treating sections with a mixture of glycerine and acetic acid; the micrococci in such preparations become yellowish brown and prominent amid the perfectly translucent structures.

Tincture of iodine has proved in our hands an excellent staining fluid for bacteria within tissues. If a section has first been treated with a solution of caustic potash, iodine stains the micrococci deep yellow, while the rest of the tissue is only slightly tinged.

The most important distinguishing point between micrococci on one hand and organic and inorganic particles on the other hand is obtained by culture. Micrococci will always multiply, though at some times much more rapidly than at others. They elongate, divide, form chains or zooglæa masses if brought into a suitable culture medium.

If the above-mentioned distinctive points are observed, mistakes in recognizing micrococci and other bacteria are entirely out of the question.

In regard to the question of magnifying powers used in recognition of micrococci, we can affirm (contrary to statements of some other investigators) that a good one-fifth objective is sufficient for the detection of the diphtheritic micrococci, particularly when appropriate staining is used. We have seen no micrococci with a magnifying power of 1,500 which we could not detect with an amplification of 500 diameters. For the finer morphological details of micrococci a high magnifying power is required, and we have habitually used a one-twelfth Zeiss Homog-Immerson.

We desire also here to state that as the result of much experience we are positive that the excessive precautions often insisted upon by authors as necessary in looking for micrococci in the blood, &c., are not in fact necessary. Micrococci do not exist in the air to any great extent, and exposure of blood slides for a few minutes to the air is never followed by the appearance of micrococci when none have previously existed. This is not true of moving bacteria, which in their early growth we ourselves have in some of our former researches mistaken for micrococci, and which may appear rapidly in exposed blood. In order, however, to disarm criticism, we have in all our blood examinations used the utmost precautions.

B.—*Morphology of the micrococci as observed in cases of epidemic diphtheria, in the local cases of sporadic diphtheria, and in induced diphtheria in animals.*

When a diphtheritic false membrane was examined (by teasing it in glycerine or fresh aqueous humor) under the microscope, immediately after its removal from the pharynx, or the air passages, there was seen, besides the cellular constituents, only one kind of bacteria, viz, micrococci.

Diphtheritic membrane removed some hours previous to examination or removed *post mortem*, in addition to micrococci, yielded other forms of bacteria as described by authorities. Unless the diphtheritic alteration becomes of gangrenous character, we are not able to detect any other bacteria than micrococci. Eberth, who describes only rod bacteria in diphtheria, or those investigators who describe different varieties and mycelium of bacteria, probably examined only membranes removed some time previously, or such as were removed *post mortem*.

Our experience with a large number of cases is so absolute that we believe the occurrence of rod bacteria is proof that a membrane has begun to putrefy. It may be that in endemic or mild diphtheria the micrococci have not the power of growth that they have in malignant diphtheria, and that consequently rod bacteria have a better chance to develop than in the membrane of the malignant disease.

The micrococci were in every case of at least two sizes, according to their stage of development, or to earlier or later generation (see culture accounts). The smaller ones mostly infested leucocytes and mucous corpuscles, within which they were seen dancing in a trembling motion (the appearance has been well compared with flies caught in a fly-trap). The larger micrococci were nearly all in zooglæa form, or *infesting and apparently destroying* the epithelial cells. The latter fact is *not* in accordance with the observation of Klebs and Eppinger, who assert that the micrococci in diphtheria never infest the epithelium, but merely penetrate between the cells.

In the blood of patients suffering from the epidemic diphtheria at Ludington we always found micrococci within the white blood corpuscles (never the red ones), or in zooglæa form or to some extent free, just as they exist in the membrane. Notably the quantity of micrococci was always in the direct proportion to the intensity and the stage of the disease, as recorded in the first chapter of this memoir.

C.—*Methods and objects of culture.*

We have employed two distinct methods of culture. The first is that described by Dr. E. Klein, of London, in his report on infectious pneumo-enteritis, from whose paper the following cut is abstracted:

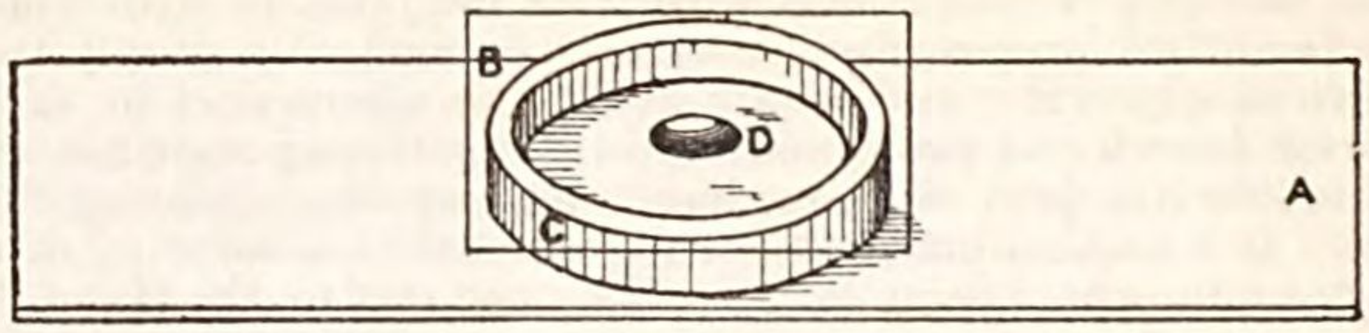

FIG. 9.

Figure I represents, of natural size, one of the culture cells.

A is the object-glass; B is the covering-glass, fixed by means of a thin layer of oil upon the upper (polished) surface of the glass ring C, which is cemented on the object-glass. The covering-glass, which should be as thin as is obtainable, has on its lower surface the droplet D, in which the fungus has been planted. In using this method the minutest speck of the infected material is removed with the point of a clean (previously heated) needle, and placed in a drop of fresh aqueous humor of the eye of a healthy rabbit, or some thoroughly sterilized culture fluid, on a thin square glass-slip. This is inverted and fixed, drop downwards, by means of a thin layer of pure sweet-oil on the glass ring.

The preparation thus mounted was placed in the incubator or oven, where the temperature was automatically maintained at various points, not below 32° and not above 45° C. In most cases we used a temperature of 37° C.

After twenty-four hours the specimen, which we will call the first generation, is used to establish a second generation in a new drop of culture fluid in the following manner: The covering-glass of the above "cell-specimen" is lifted up, and, with the aid of a fine capillary tube, a minutest quantity is removed from the edge of the droplet. In the accompanying Figure II this capillary tube is portrayed in its natural size; the contents of the tube between *a* and *b* represent about the quantity that is removed from the drop D of the previous specimen. The capillary tube is then filled with culture fluid up to about the mark *c*. A new clean covering-glass is taken; on its center is deposited a droplet of fluid from our capillary tube, and the covering-glass is then inverted and fixed with a thin layer of oil on the glass ring of another "cell." This new preparation, which represents the second generation, is also placed in the incubator and kept there at the above-named temperature for twenty-four hours. After this time it is used to inoculate another "cell-specimen," representing the third generation, and so on, from generation to generation, until the end of the culture.

FIG. 10.

The second method employed was that perfected by Dr. Sternberg, which we believe has been already described by him in the publications of the National Board of Health. This plan has the advantage over the method of Klein that the cultures can be made on a larger scale for the purpose of inoculation of animals, but we have found the cell and glass cover more useful in observing the growth and development of the fungus.

The following objects were put in cultivation:

Sporadic diphtheritic pseudo-membrane, fresh and dried.
Epidemic diphtheritic pseudo-membrane, fresh and dried.
Fragments of spleen and kidney from epidemic diphtheria.
Pseudo-membrane from artificial croup, produced by ammonia.
Blood from diphtheria.
Blood from septicæmia.
Blood from scarlatina.
Gangrenous matter from foot.
Scrapings from tongue and mouth of normal individuals.

As a medium for the culture of the diphtheritic fungi the following fluids were used with the best results: Bouillon of chicken or rabbit, perfectly sterilized by protracted boiling; ascitic fluid whenever there was opportunity to put it in sealed tubes immediately after tapping; aqueous humor, which is drawn from living animals by a little sharp-pointed pipette, as represented in Figure II, with great facility. Other culture mediums, such as solution of gelatine, egg albumen, Pasteur's fluid, solution of dextrine, and simple syrup, were also tried, but with less satisfactory results.

As control experiments the culture fluids were usually tested by placing sealed cells in the incubator for twenty-four hours, but no organisms developed in successful cells or tubes.

D.—*Biology of the diphtheritic micrococci as observed in culture.*

If a minute particle of fresh diphtheritic matter or some scraping from tongue be put into a drop of pure culture fluid in a cell fixed in a manner as described, there are seen under the microscope a few epithelial scales infested by micrococci averaging in size $\frac{1}{28000}$, but sometimes reaching a maximum of $\frac{1}{14000}$ of an inch, and a few leucocytes, filled with minute micrococci, which, on account of their extremely small size and their trembling motion within the cell, cannot be measured; the surrounding liquid is clear, and will remain so for from six to twelve hours if kept in a cold room; but after having been placed for one single hour in the incubator at a temperature of 40° C., slight clouds appear around the particles in the droplet.

Observed under the microscope and watched for several hours, the micrococci are seen to undergo the following changes:

The micrococci contained in the leucocyte after a period of slight but very active movement, during which they look as if they were eating up their foster nurse, pass into a quiet state. They now completely fill the corpuscle, which appears to burst, and the whole internal mass escapes as an irregular glass-like body, full of quiet uniform micrococci of about $\frac{1}{30000}$ of an inch in diameter, the whole constituting the so-called "zooglæa masses." Often the collapsed vesicle was seen lying alongside of such a mass just escaped from it.

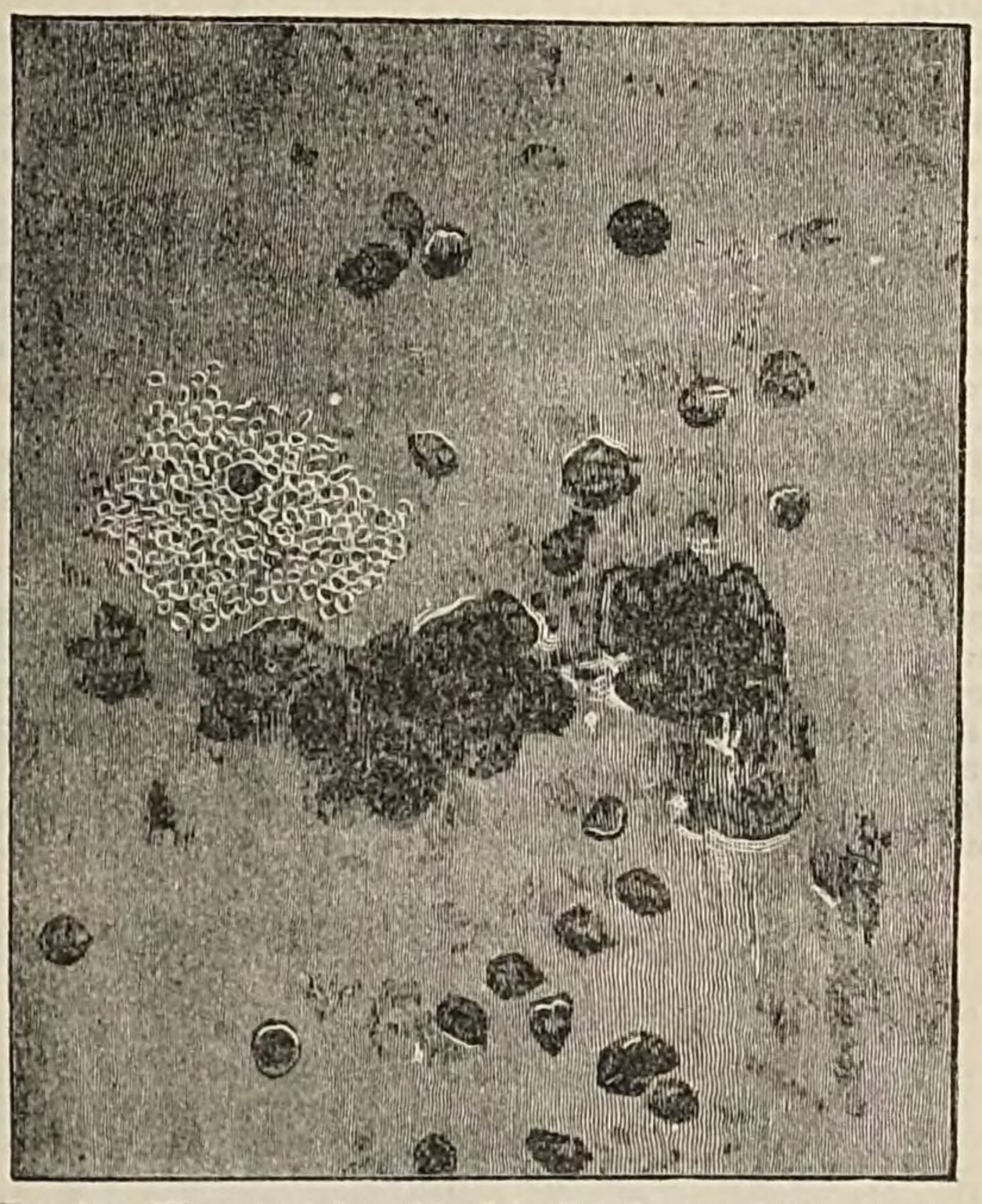

FIG. 11.—Micrococci from blood in diphtheria × 1,000, showing aureole.

The finer micrococci and those infesting the epithelial cells have grown larger and acquired a faint yellowish-green color. Some of them can always be seen to be undergoing the process of division, which is better studied, however, a little later.

After twenty-four hours the zooglæa masses can be seen to be breaking up and setting free small individual micrococci. The larger micrococci have in the meanwhile elongated; some of them resemble in appearance short rod bacteria, whilst others of them are constricted in the middle like the Arabic figure 8. The latter forms have a peculiar trembling motion, as if they were making an effort to separate the two parts. Except in the case of the peculiar vibration already noted inside of the leucocytes and this trembling before division, we have found the micrococci always motionless.

The aureole of mucous substance surrounding the isolated micrococci, particularly well described by Pasteur and Sternberg, is well marked at this stage, and is a mark of a stage of development not of a specific form. In color the larger micrococci are somewhat greenish-yellow, while the smaller ones are colorless.

After the lapse of forty-eight hours multiplication is seen to have continued, and to be occurring in micrococci originally derived from the balls. A large number of micrococci are observed elongated or in pairs, and also a few are arranged in fours, so as to resemble a sarcina, and in chains. After this no further multiplication will occur, unless new culture pabulum be added. In a second generation the multiplication will proceed in a very vigorous manner, so that within twenty-four to forty-eight hours a fresh droplet of culture fluid to which only a few micrococci have been added on a pin is completely filled out with millions of mostly round micrococci. The different forms of grouping are best expressed on the second and third day of culture. Vigorous multiplication continues also in the third and fourth generations, and occasionally in the fifth, but in later generations up to the eighth the rapidity of multiplication gradually subsides, and is hardly perceptible in a ninth or tenth generation. It is said by some authorities that micrococci kept for a while in a culture tube

will diminish in quantity and even disappear; we cannot affirm this from our own experiments. Micrococci may cease to multiply, but in many instances a diminution in their quantity had not been perceptible even after the lapse of months.

The above history refers to micrococci from true malignant diphtheria; in the case of cultures of tongue-scrapings the micrococci ceased to multiply as early as the third generation, and frequently in the second generation their growth was very slow. In addition, in tongue-scraping, some leptothrix threads frequently accompanied the micrococci in the first and second culture, and, as also as in diphtheritic culture, bacterium termo made occasionally its appearance in early generations, but *it promptly disappeared if the temperature in the incubator went for a while to* 40° and did not afterwards sink below 35°. Later generations in successful cultivation remained always clean in well-regulated temperatures and never showed any kind of mycelial fungi. Cultures with sporadic Philadelphia diphtheria gave results very similar to those achieved with tongue-scrapings; the micrococci possessed some but not very much more vitality or proliferating power, their growth usually ceasing in the fourth generation.

In regard to temperature we can affirm from our own culture experiments the following interesting facts with special reference to diphtheritic micrococci.

The micrococci multiply best at from 37° to 40° C.; higher temperatures up to 70° C. do not destroy them, but only partly arrest their multiplication, which returns, however, if the 70° is again reduced to 40° or 35°.

Fungi other than micrococci, if met with as an admixture in our culture, perished at a temperature above 50°, and proliferated well only at 30° C. and below. Too low temperature frequently spoiled our cultures, for if any spores of rod bacteria were present they usually developed and displaced the micrococci. In high temperatures, however, the micrococci are stronger and displace easily the several kinds of bacteria we observed in impure cultures.

The diphtheritic micrococci do not seem to need a large supply of oxygen for their growth; they even appear to multiply better when distant from surfaces, in contradistinction from the bacteria of putrefaction.

In culture tubes the diphtheritic micrococci are always seen as a precipitate. If there is any mycoderma at the surface it is always a sign that the culture is impure, since the bacteria found on the upper surface are always rod bacteria and bacilli, with very few micrococci. This property renders the micrococci especially fitted to flourish in dense membrane and in deep tissue, where the supply of oxygen must be very small.

In the following tables are given, in sufficient detail, the several series of cultivations which we have made.

II.—Culture Experiments.

FIRST SERIES.

Diphtheritic False Membrane from the Cases of Dr. H. Allport.

Culture experiment, representing Nos. 1 to 20.

MICROCOCCI.—[Matter used: fresh diphtheritic pseudo-membrane. Case of Dr. Allport.]

Date.	No. of generations.	Culture fluid.	Mode of culture.	Temperature in incubator.	Size of.	Quantity and rate of multiplication.	Mode of grouping.				
							Isolated.	In pairs.	Sarcina form.	Torula chains.	Zooglaea.
During April and May, 1881	First	Aqueous humor of rabbit.	Cells	35° to 40° C.	$\frac{1}{20000}$ to $\frac{1}{40000}$ of an inch.	At first slow, then rapid.	Many.	Few ..	Few ..	Few ..	Many.
	Second	do	do	do	do	Rapid	do ..	Many.	do ..	do ..	Do.
	Third	do	do	do	do	Very rapid	do ..	do ..	do ..	Many.	Do.

Many micrococci were in huge clouds without any special of form grouping.

All the cultures of this series yielded crops of pure micrococci. No other bacteria interfered in successful tubes. Mycelial fungi were never observed.

SECOND SERIES.

Endemic diphtheritic matter obtained from time to time in Philadelphia.—Twenty-five cultures were made, and all the mentioned culture fluids were tried in this series up to a fourth generation. The comparative values of the culture fluids were referred to before.

The general results of the culture experiment were similar to those of the first series up to the second generation. In the third generation the micrococci already began to fail in growth and multiplication, and the fourth generation yielded a still poorer crop. The cultures were occasionally impure—the rod bacteria supervened.

The regulation of the temperature was sometimes defective during the experimentation with this series on account of imperfect working of the mechanism of the incubator. Sometimes the temperature fell down to 20° during the night, and it was frequently observed that rod bacteria made promptly their appearance in large numbers during such intervals and spoiled the cultures. The same occurred with clean cultures when heat was suspended purposely for several days. Those culture tubes, however, which were subjected to a uniform temperature of not below 37° C. did not show any invasion of rod bacteria, and the growth of micrococci continued in the manner described.

The careful measurement of the micrococci in this series, which was best accomplished by measuring the chains of micrococci, revealed a size of $\frac{1}{14000}$ to $\frac{1}{42000}$ of an inch in diameter, the first size relating more to micrococci in zooglæa form. The torula chains were usually made up of the smallest micrococci, approaching in this respect to those of the micrococci balls which we have proven to be formed by the invasion of leucocytes by micrococci.

THIRD SERIES.

Thirty cultures were made with matter other than diphtheritic, being carried on to the fourth generation. Although the matter used was of the most diverse character, such as ammonia croup (croupous exudation produced in the trachea of a rabbit by ammonia), slough from gangrene of foot, yet the results in culture were nearly all identical.

One and the same thing gave at one time an excellent crop of micrococci if the temperature of the incubator was kept up high enough and pains were taken to keep the culture pure; whilst at another time with the same culture fluid the same tube showed only a few micrococci, but rod bacteria in abundance; this could nearly always be traced to low and irregular temperature of the incubator. In some cases after the replacing of the micrococci by rod bacteria, the tubes were subjected to a high temperature for several days, when the bacteria disappeared, whilst the micrococci did not reappear, so that the liquid was left clear. But even in successful cultures the growth and multiplication of micrococci were observed to be prosperous only to the second or very rarely to the third generation. In later generations the fungi grew scantily.

Micrococci from epidemic diphtheria, fifth generation × 1,000.

In size, shape, and color, as well as in the mode of grouping, the micrococci were the same as those from the diphtheritic pseudomembrane. If this were not the case in one generation, it invariably was so in the next.

FOURTH SERIES.

Twenty-five cultures were made with epidemic diphtheritic matter from Ludington, and were carried on to the fifth generation. The results were identical in every one of the successful cultures, and the record of one experiment holds good for all the rest.

Neither rod-bacteria nor mycelium could be detected at any time of culture. One of the culture tubes did not show any change in appearances when examined two months later, it having been kept during the whole time in the incubator.

Culture experiment, representing Nos. 76 to 100.

MICROCOCCI.—[Matter used: dried diphtheritic membrane. Case of Dr. Shorts, Ludington.]

Date.	No. of generation.	Culture fluid.	Mode of culture.	Temperature in incubator.	Mycoderma or precipitate in tube.	Size of.	Quantity and rate of multiplication.	Mode of grouping.				
								Isolated.	In pairs.	Sarcina form.	Torula chains.	Zooglaea.
During July, 1881	First	Bouillon or ascitic fluid.	Cell and tube.	37° C.	Precipitate.	$\frac{1}{35000}$ to $\frac{1}{14000}$	Slow; twelve hours later slow but marked.	Few.	None.	None.	None.	Moderate quantity.
	Second, next day	...do	...do	39	...do	...do	Faster; ten hours later rapid.	Many.	Many.	Some.	None.	Large quantity.
	Third, third day	...do	...do	38	...do	...do	Rapid	Large quantity in all forms of grouping.				
	Fourth day	...do	...do	40	...do	...do	Enormous	Cell specimen is so crowded that mode of grouping is indistinguishable.				
	Fourth, fifth day	...do	...do	39	...do	...do	Rapid	In all forms.				
	Fifth, seventh day	...do	...do	38	...do	...do	Slower	In all forms, mostly torula chains and zooglaea forms of yellowish color.				

FIFTH SERIES.

Forty cultures were made with epidemic diphtheritic false membrane received from Ludington per express, and were carried to the tenth generation. The membrane was in a semi-dry condition, and showed under the microscope the following morphological elements:

Epithelial scales and leucocytes, both infested by clouds of micrococci. The micrococci were of two sizes, larger ones of a greenish color, measuring about $\frac{1}{14000}$ of an inch in diameter, and smaller ones not exceeding $\frac{1}{35000}$ of an inch. There were also seen some rod-bacteria and bacilli, and also a number of bundles of mycelial threads, resembling leptothrix, of greenish color, united together at one end, but separated at the other. These extraneous organisms disappeared, however, in proper culture.

Particular pains was taken to have always a uniform temperature in the incubator and not exceeding 37° C. The results obtained were nearly identical with those in the fourth series. Only these cultures were conducted up to the tenth generation, and a larger proportion of impure culture were encountered here, mostly dependent upon thermal conditions. The record of one of the many uniform and successful culture experiments reads as follows:

Culture experiment, representing Nos. 101 *to* 140.

MICROCOCCI.—[Matter used: diphtheritic membrane removed five days previous by Dr. Shorts, of Ludington.]

Date.	No. of generation.	Culture fluid.	Mode of culture.	Temperature in incubator.	Size of.	Quantity and rate of multiplication.	Mode of grouping.					
							Isolated.	In parts.	Sarcina form.	Torula chains	Zooglœa.	Rod bacteria.
July 23	First	Bouillon of rabbit.	Cells and tubes.	45° C. (with the object to kill the extraneous fungi).	$\frac{1}{35000}$ to $\frac{1}{14000}$	Slight	Many.	A few.	None.	None.	Some.	A few.
24	Second	....do	....do	37	..do ...	Rapid	..do ...	Many.	Some.	..do ...	Large quantity.	None.
25	Third	....do	....do	37	..do ...	Enormous	..do ...	..do ...	..do ...	..do ...	..do ...	Do.
26	Fourth	....do	....do	37	..do ...	Rapid	..do ...	..do ...	..do ...	Many.	..do ...	
28	Fifth	....do	....do	37	..do ...	Slower	..do ...	..do ...	..do ...	..do ...	..do ...	
29	Sixth	....do	....do	37	..do ...	Slow	..do ...	..do ...	..do ...	..do ...	..do ...	
31	Seventh	....do	....do	37	..do ...	....do	Only isolated and in torula form.					
Aug. 2	Eighth	....do	....do	37	..do ...	Very slow	Do.					
4	Ninth	....do	....do	37	..do ...	Hardly perceptible, or not at all.	Do.					
7	Tenth	....do	....do	37	..do ...	....do	Do.					

Neither mycelium nor rod-bacteria were observed in successful cultures, except in the early (first and second) generation.

SIXTH SERIES.

Cultivation of tongue-scraping.—To test the behavior of the micrococci from the mucous membrane of the tongue in cultures, five experiments were made and carried to the fourth generation. In every experiment a result was obtained that the proliferating power of these micrococci was very weak in comparison with those of the diphtheritic exudate. Only in the second generation they multiplied rapidly and precisely in the same manner as the diphtheritic micrococci, and in this generation they are morphologically perfectly identical with them.

SEVENTH SERIES.

Five cultures were made with epidemic diphtheritic matter which had been for two months exposed to air and light, frequently to the direct rays of the sun. The results of the culture were surprising, as it was found that the micrococci of this dried membrane had lost a great deal in their proliferating power. In the second generation a moderate crop of micrococci were obtained, whilst in the third generation very slow or hardly any multiplying property could be observed.

This shows distinctly that the same diphtheritic micrococci which in the fourth series of cultures had a vigorous power of growth and multiplication had lost greatly these properties (simultaneously with the loss of virulence upon animals).

CHAPTER IV.

ON THE RELATIONS OF THE MICROCOCCI TO DIPHTHERIA.

In the present chapter we propose considering the rôle which micrococci play in diphtheria. Before detailing our own work, it seems but proper to give a brief *résume* of that which has been done by others. We shall do this under two headings.

SECTION A.—*BIBLIOGRAPHICAL.**

(I.) IN FAVOR OF THE FUNGOID ORIGIN OF DIPHTHERIA.

OERTEL (*Studien über Diphtherie Aerztl. Intelligenzblatt*, 1868, No. 31) was the first to speak of micrococci as occurring in diphtheritic pseudo-membrane, and also in the blood, the lymphatic vessels, and the kidneys of persons affected by diphtheria. He describes them as "point-like, dark-contoured, round or oval (immovable)" little bodies, occurring either isolated or in zooglæa form. Later (*Deutsches Archiv f. klin. Medicin*, 1871, p. 242, and in *Ziemssen's Encyclopædia*, 1874), Oertel describes the diphtheritic fungi to be spherical bacteria (micrococci, accompanied by a larger or smaller quantity of bacterium termo). He thinks that they are the direct cause of the diphtheritic inflammation; that long before any false membrane is formed they attack the mucous membrane and induce the disease.

Oertel experimented as follows:

First series.—Produced ammonia croup in rabbits; found few or no micrococci in the false membrane, and never any in the blood and organs. Hence he thinks that croup must be strongly separated from diphtheria.

Second series.—He inoculated with true diphtheritic matter in the trachea, twelve rabbits, three pigeons, and two chickens; and produced local lesions and constitutional disturbances perfectly identical with those of diphtheria in man; micrococci were found abundant in the blood of the poisoned animals.

Third series.—He inoculated rabbits with true diphtheritic matter, placing the poison below the skin and in the muscles, with the same results as in the second series

Fourth series.—He inoculated rabbits with pyæmic pus and gangrenous tissues with negative results.

Fifth series.—He succeeded by inoculations in the trachea in transmitting the disease—

1st. From man to rabbit No. 1.
2d. From rabbit No. 1 to rabbit No. 2.
3d. From rabbit No. 2 to rabbit No. 3.
4th. From rabbit No. 3 to a pigeon.
5th. From the pigeon to rabbit No. 4.

All the animals died with lesions peculiar to diphtheria within thirty to forty hours. How the bacteria acts he says is not known.

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*This paper was sent by its authors to the National Board of Health in September, 1882; of course literature of a later date is not considered.

Oertel further affirms that the quantity of fungi present in any case bears a direct relation to the intensity of the morbid process; they multiply as the disease advances and diminish with its retreat. Also, that the special form of fungus is never present in simple inflammation of the fauces or in mercurial stomatitis; but that, if the diphtheritic process intervenes on these disorders, the fungus at once makes its appearance, and quickly displaces the more common forms of bacteria which are present.

NASSILOFF (*Virchow's Archiv*, vol. 50, 1870), from his observations and experiments, came to the conclusion that the fungi found in diphtheria are identical with those occuring in decomposing animal tissues. His conclusions are:

(1.) Fungi are always present in diphtheritic membranes.

(2.) The development of the fungi precedes the formation of the membrane, and the fungi are the direct cause of the necrotic changes in diphtheritic inflammations.

(3.) The fungi penetrate into the tissues by way of the juice channels and lymphatics before any changes in those tissues can be observed, so that fungi are the cause of the inflammation and the destruction of the parts affected.

HUETER AND TOMASSI (*Med. Central-Blatt*, 1868, Nos. 12 and 34), also established by experiment the direct causative relation of micrococci to diphtheria. They placed particles of diphtheritic membranes in the muscles of the back of rabbits. Death followed promptly within forty hours. The tissues at the seat of inoculation were inflamed and inves ed by very small, roundish micrococci. The latter were found also during life in the blood of the infected animals.

TRENDELENBURG (*Arch. f. klin. Chirurgie*, 1869, vol. 10) put diphtheritic matter in the trachea of rabbits and pigeons. He succeeded in producing false membrane only in eleven out of sixty-eight experiments; in the blood of rabbits inoculated with diphtheritic matter he frequently found micrococcci, sometimes even in those animals in which a distinct false membrane had failed to appear. Frequently, but not always, he found micrococci in the blood of children suffering from the disease.

Trendelenberg doubts whether the micrococci as found in the blood of diphtheritic patients are peculiar to diphtheria, and does not believe it to be proof of the transmission of diphtheria to animals if at the seat of inoculation a diphtheritic inflammation is produced.

EBERTH (*Correspondenz-Blatt der schweizer Aerzte*, No. 1, 1872) discovered in 1871 micrococci in the blood and the tissues of persons who had died of diphtheria, but was not able to detect the fungi in the blood or even the false membrane of patients suffering from true croup.

Experimentally he succeeded in reproducing diphtheria in animals, which died in three days.

Diphtheria of wounds, Eberth thinks, stands in close relation to pyæmia. Pyæmia, he says, "is a diphtheria proceeding from a wound." The bacteria of diphtheria and pyæmia he believes to be identical.

LETZERICH (*Virchow's Archiv*, 1873, vol. 58) claims to have produced local and general diphtheritic lesions with the fungi filtered out from the urine of individuals suffering from that disease. When the dried urine filter, with the pure fungi on it (all other foreign matter having been washed out by means of hot water), were introduced into the uninjured mouths or vaginas of rabbits, diphtheritic pseudo-membranes and death followed in from three to five days.

He describes the fungus as occurring in four forms.

First. Constituting small balls composed of a hyaline substance, which is colored blue by iodine and sulphuric acid, and of small punctiform roundish or elliptical little bodies, which may increase until the whole mass becomes very dark.

Second. Large balls "*Plasmakugeln*" with a seeming outer membrane.

Third. Large irregular masses formed by the bursting of these balls.

Fourth. True mycelial filaments which produce spores of a tilletia, and are named by Letzerich *Tilletia diphtheritica*.

COHN (*Beiträge zur Biologie der Pflanzen*, 1872 and 1873), who regards bacteria as algæ, classes the diphtheritic plant with the schizophytes; tribe, sphæro-bacteria, and calls it *Micrococcus diphtheriticus*. He gives as its specific character: Perfectly round, less than one micromillimeter in size; in multiplying, first forms in pairs, then several joint, then chains, and finally zooglæa masses, but never any mycelium.

KLEBS (*Correspondenz-Blatt der schweizer Aerzte*, 1871, No. 9) thinks that micrococci do develop a *mycelium* resembling *Leptothrix buccallis*, but somewhat thinner or more delicate than it is. This diphtheritic mycelium forms on the surface of affected membranes dense bunches upon which spores are produced. The latter collect in masses in zooglæa form of various size and shape. Between these groups occur free micrococci ("*Monades*"), micrococci chains, and rod bacteria. The greatest destruction of tissues is produced by the zooglæa.

Klebs agrees with Eberth concerning the identity of diphtheritic and septic micrococci. In his latest publication (*Archiv für experiment. Pathologie und Therap.*, vol. 4, p. 191), Klebs describes the diphtheritic fungi as follows:

First stage.—Very small micrococci forming in the quiescent state sharply defined

round balls, the individual micrococci being united in rows or chains and imbedded in a very scanty gelatinous matter.

Second stage.—Peripheral layers of the micrococci balls give rise to mobile bacteria, which do not need much oxygen, and have a tendency to penetrate into and live within the tissues and juices where not much oxygen is present.

Third stage.—The highest form of development consists in the formation of a mycelium in the tissues. The threads are never branching, and arrange themselves parallel to one another, covering the outer surfaces like the grass in the turf. Occasionally mycelium masses may form in deeper structures of the organisms.

Professor Klebs also gives the following as peculiarities in the life-history of the diphtheritic fungus:

(*a.*) They can grow and develop without oxygen.

(*b.*) They are killed only by a temperature of 65° to 70° C. (Not below that.)

(*c.*) In themselves they do not develop any fœtid gases.

(*d.*) They are sometimes of intensely yellow color.

(*e.*) They may circulate in the blood, but preferably are deposited outside the blood-vesssels, where they may form mycelial masses.

They never penetrate into the substances of the epithelial cells, but go between them (Klebs and Eppinger). They afford a distinction between diphtheritic and inflammatory croup.

M. Ch. Talamon describes a fungus as the true diphtheritic poison, which has a remarkable resemblance to a penicillum. We quote from a translation in the *Chicago Medical Examiner*. He says he has cultivated it in damp cells, and, that after its evolution is completed, it appears under the shape of mycelia and characteristic spores. These mycelia sometimes appear as long tubes, partitioned from distance to distance, specially refracting the light, and generally very clear; they are from 2 to 4 and 5 thousandths of a millimeter wide (.000002 to .000005). When the fluids are well conditioned they stretch extremely, at times branch off, and these divisions are themselves peculiar; they form by their slightly incurved branches a figure best compared to a lyre or a tuning fork. At other times the mycelia do not stretch in this way, although multiplying so as to rapidly cover the surface of the liquid of cultivation, they remain short, take on odd shapes, the most common of which resemble a crutch; there is always present, then, a multitude of straight cylinders, 4 or 5 thousandths of a millimeter wide by 15, 20, or 40 thousandths long (.000004^{m} by .00005^{m} or .00004^{m}).

There are two kinds of spores—round or oval—which may be considered the spores of germination, and rectangular spores which represent the last phase of growth of the fungus, and which we will call conidia (conidies). These give the species its particular character; their shape is rectangular and their size very liable to vary; their width varies from m. .000005 to .000015. Sometimes they are isolated, other times they are in groups of 2 or 3; often they form beads of 10, 12, or 15 individuals, or a small chain in zigzag. Homogeneous at first, they soon become filled with small, round, bodies, very brilliant, the size of common micrococci, which appear to me as the true germ of the fungus.

The round or oval spores form the mycelium by stretching; they look like bright specks m. .000003 to .00005 in diameter, in the middle of granular matter, spread in sheets of greater or lesser extent, which represent what is called zooglea. The spores stretch one of their poles so as to form a tube m. .000002 to .000004 in diameter which branches as above stated. When the lengthening of the mycelium is first begun, the space with its prolongation represents a tadpole. Mr. Talamon claims to have produced diptheria in rabbits, guinea pigs, cocks, and pigeons by inoculating with this fungus, and even some frogs who were fed upon the fungus promptly succumbed to the disease.

(II.) AGAINST A FUNGOID ORIGIN OF DIPHTHERIA.

Senator (*Berliner Klin. Wochenschrift*, 1872, Nos. 26, 27, 31, *and* 33, and *Volkmann's Sammlung klin. Vorträge*, 1874, No. 78) declares himself decidedly against a fungoid origin of diphtheria, on the following grounds:

Other diseases of the mouth and the pharynx are accompanied by the same micrococci which are also found in the mucus between the teeth and in the urine of the normal man, micrococci being only the spores of *Leptothrix buccallis*. The diphtheritic micrococci do not differ in cultures in any way from those of other origin.

Experimental proof.—Inoculations with any putrefying substances have given the same local and secondary changes as those produced by true diphtheritic material.

Scarlet fever produces precisely identical local lesions in pharynx as those which occur in diphtheria.

Micrococci multiply enormously on account of the favorable conditions in the pharynx created by the deep-seated ulceration; when ulceration is absent, as in the larynx, the micrococci are in only very moderate number; probably the carbonic acid is exerting also some antiseptic effect in the latter case.

BILLROTH (*Untersuchungen über Vegetationsformen der Cocco-bacteria Septica, &c.*, Berlin, 1874), who investigated the bacteria question exhaustively, came to the conclusion that they are only concomitant with diseases, and expresses himself positively against the view that the different affections are caused each by special forms of bacteria. He says that the so-called pathogenic bacteria of diseases are positively identical with those found in putrefying dead tissues.

LEBERT (*Ziemssen's Handbuch der acuten Infectionskrankheiten*, vol. 1, p. 255) is also against the fungoid theory, on the ground that nothing has yet been proven.

WAGNER thinks there is a great difference between the human pseudo-membrane and the experimentally-produced false membrane.

BEALE (Diseased germs, London, 1872) denies specific fungi altogether.

NAGELI thinks that all varieties of bacteria are derivatives of one and the same species of fungi.

Dr. JACOBI, of New York, also entirely dissents from the fungal origin of diphtheria.

Dr. C. HARLEY (Pathol. Transact., vol. x, p. 315) failed to inoculate animals with diphtheritic membrane.

In a voluminous study of the subject, Drs. SATTERTHWAITE and CURTIS (Report of Dr. Edw. Curtis and Thos. Satterthwaite to the New York City board of health, New York, 1877) are also opposed to the fungal theory, on account of the following facts and deductions, founded upon their own researches:

First. The bacteria of diphtheritic membranes do not differ in optical or chemical behavior from those found in putrescent but non-diphtheritic animal material.

Second. They believe the disease produced in rabbits by diphtheritic inoculation is not diphtheria, and find that "Scrapings from the upper surface of a somewhat furred tongue from a healthy person" produce, when placed in the cellular tissue of the rabbit, symptoms and results exactly similar to those caused by inoculations with diphtheritic membrane; also that inoculations of rabbits with putrid Cohn's fluid produce similar results to those.

Third. Salicylic acid added to the diphtheritic matter does not prevent its action, although, as they believe, it acts fatally upon the germs.

[This last objection is not, as it seems, a conclusive reason, for it is very possible that salicylic acid may arrest the growth of micrococci without killing them. In the experiments of Curtis and Satterthwaite it was shown that before the injection the micrococci did not grow in the presence of the salicylic acid; after the injection the salicylic acid is undoubtedly removed from the injected material by being absorbed into the system, the micrococci remaining largely at the seat of inoculation. Under these circumstances, if the micrococci were only benumbed, not killed, by the acid, they would of course soon begin to grow and assert themselves.]

SECTION B.—*ORIGINAL STUDY.*

The first series of experiments with the lower animals which we made had for their object to determine whether it is possible to produce the diphtheria in them by inoculations of diphtheritic matter. Clinically the mild form of the disease which is seen so constantly in our large cities separates itself from the malignant epidemic which occurs at intervals in various localities, although even in what may be termed endemic diphtheria malignant cases occasionally do occur. Following this clinical variation, we have separated our experiments with inoculations into those made with material obtained from cases occurring in this city when no epidemic influence was rife and those taken from cases during distinct epidemics in several localities.

SECTION A.—ENDEMIC DIPHTHERIA.

FIRST SERIES OF EXPERIMENTS.

Inoculation with diphtheritic matter subcutaneously and in the mucous membrane of the mouth.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy, and of microscopic examination.	Remarks chiefly upon source of matter employed.
1	Apr. 22	Small rabbit, No. 1	Inoculated on tongue with fresh diphtheritic membrane.	Remained perfectly well to May 16, 24 days, when they were accidentally killed.	No signs of diphtheritic inflammation anywhere. The spleen, lymph, glands, liver, and lung showed some tubercle granulations. The rest of the organs normal. No bacteria in the organs.	Case I.—Material taken by Dr. Cardeza from child, 3 hours previously to inoculation. Child's throat had been touched with tincture of iron and glycerine previously.
2	Apr. 22	Small rabbit, No. 2	Same as last			
3	Apr. 24	Small rabbit, No. 3	Same as last	Remained well		Same case. The throat for 24 hours previous to the removal had not been touched by anything.
4	Apr. 24	Small rabbit, No. 4	Same as last	Died May 10	No lesions except lymphatic glands swollen and tuberculous; also spleen. No bacteria in organs.	Same case, and exudation as last.
5	Apr. 24	Large gray rabbit, No. 5.	Inoculated in mouth; had also a piece of membrane put under the skin of the side.	May 4, was feverish for several days; a hard lump developed on the side at the seat of inoculation consisting of cheesy matter. June 6, animal well, cheesy lump smaller but persistent. Animal remained well.	Cheesy matter composed of pus, compound granule cells, débris, and numerous bacteria.	Same case. The child recovered from the acute attack, which was followed by paralysis, finally resulting in death.
6	Apr. 29	Small albino rabbit, No. 6.	Inoculated with fresh diphtheritic membrane in mouth, tongue, roof, and pharynx, and also subcutaneously on thigh.	Died May 2, 70 hours after inoculation, in convulsions, which commenced 6 hours previous to death.	Small cheesy lump at the seat of subcutaneous inoculation. Tongue ulcerated; no signs of diphtheritic inflammation anywhere; all organs hyperæmic, otherwise of normal appearance, but upon microscopic examination tubercular granulations well marked in lung, liver, spleen, and lymphatic glands. No bacteria in organs, except lungs, where are also hemorrhagic infarctions.	Case II.—Removed by Dr. Dunmire from the throat of child a few hours previously.
7	Apr. 29	Small albino rabbit, No. 7.	Same as last	Animal remained well		Same case.

First series of experiments.—*Inoculation with diphtheritic matter subcutaneously and in the mucous membrane of the mouth*—Continued.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
8	Apr. 29	Small rabbit, No. 8	Same as last	Remained well to May 1, when killed accidentally.	Post mortem revealed no lesions...	Case III.—From Dr. Cardeza; inoculation made 15 minutes after removal of the membrane from the child's throat. This case was in family of No. 1, and originated apparently by contagion.
9	Apr. 29	Small rabbit, No. 9	Same as last	Remained well to May 16, when accidentally killed.		
10	Apr. 29	Albino rabbit, middle sized, No. 10.	Same as last	Remained well.		
11	Apr. 30	Rabbit, No. 3	Reinoculated with diphtheritic matter in mouth and subcutaneously. May 7, inoculated third time.	Remained well up to May 13; found dead May 14.	Small cheesy lump on thigh at the place of inoculation. All organs tubercular, otherwise to the naked eye of normal appearance. No bacteria in organs.	Case IV.—From Dr. James Collins, twelfth day of disease. Matter semi-liquid, mixed with blood. The case afterward died.
12	Apr. 30	Dog, No. 1	Inoculated with diphtheritic membrane in mouth and thigh.	Remained well		Same case.
13	Apr. 30	Large cat, No. 1	Inoculated with diphtheritic matter in mouth and subcutaneously on right thigh.	Remained well; a large lump developed in skin at seat of inoculation, which eventually disappeared. No micrococci in blood.		Case IV.—From Dr. Collins. Case recovered.
14	Apr. 30	Rabbit, No. 11, large albino.	Same as last.			
15	Apr. 30	Rabbit, No. 12, large old albino.	Same as last	Remained well.		
16	May 1	Small rabbit, No. 13.	Same as last	A small cheesy lump developed at seat of inoculation; died May 12.	Slight exudation on the mucous membrane of the larynx and trachea, of grayish color, and translucent. Trachea and lungs much congested. All organs tubercular; in the lungs are seen profuse hemorrhagic infarctions, and numerous bacteria. No bacteria in the organs.	Case V.—From Dr. W. S. Stewart. Membrane inoculated fresh on the day of removal.
17	May 1	Large cat, No. 2	Same as former	Remained well; lump developed on side and disappeared within a week, healing perfectly. No micrococci in blood.		Do.
18	May 1	Small cat, No. 3	Inoculated in mouth	Remained well		Do.
19	May 1	Dog, No. 2	Inoculated in mouth, pharynx, tonsils, tongue, and also subcutaneously	Remained well. Killed June 11.	Cheesy lump which had existed for a long while on the side found to have been absorbed; in its place was a	

			on the side, with fresh diphtheritic matter. The latter also given to the animal mixed with food.		hard lump, probably of cicatricial tissue. No lesions perceptible. Blood examined during life did not show any bacteria.	
20	May 4	Small cat, No. 4...	Inoculated with dried diphtheritic matter in mouth and subcutaneously.	Remained well. Killed June 12.	No lesions found; blood did not contain bacteria.	Case VI.—From Dr. Frank R. Brunner. Membrane removed several days ago from woman of 45 years; apparently much decomposed.
21	May 4	Large rabbit, No. 14.	Same as in last experiment..	Remained well. Has large lump at place of skin inoculation.	No lesions except a large cheesy lump on side. No microscopic examination made.	
22	May 4	Cat, No. 5.....	Same as last	Remained well. Killed June 12.	Large cheesy lump at the place of subcutaneous inoculation; no signs of diphtheritic inflammation; lungs highly congested, the remaining organs all appearing normal to the naked eye; but microscopic examination showed tubercular granulations everywhere; hemorrhagic infarctions in lungs; no bacteria in organs except lungs.	Case VII.—From Dr. Collins.
23	May 7	Large rabbit, No. 15.	Same as last	Remained well up to May 19. Found dead May 20.		
24	May 7	Small rabbit, No. 9.	Reinoculated with fresh diphtheritic matter in mouth and subcutaneously.	Killed accidentally.....	Post mortem revealed no lesion.....	See experiment 9.
25	May 7	Small rabbit, No. 3.	Inoculated the third time as before with fresh matter.	Died May 9.....	A small cheesy lump on thigh at the place of inoculation; all organs tubercular, otherwise to the naked eye of normal appearance; no bacteria in organs.	
26	May 9	Dog, No. 3.....	Inoculated in mouth and skin with fresh membrane.	Remained well.....	.....	Case VIII.—From Dr. James Collins.
27	May 9	Small cat, No. 6			All had cicatrizing lump at place of skin inoculation; no other lesions detected; no bacteria in blood.	
28	May 9	Small cat, No. 7	Same as the last.....	Remained well. Killed June 12		From Dr. James Collins.
29	May 9	Small cat, No. 8				
30	May 11	Goat, No. 1	Inoculated in mouth and subcutaneously with fresh membrane.	Remained well.....	.....	Case IX.—From Dr. H. C. Wood. Taken from a case the second day of the disease, the attack having been derived by contagion from the cases of Dr. Cardeza.
31	May 11	Cat, No. 9.....	Similar inoculation.....	Remained well.		
32	May 11	Cat, No. 10.....	Same as before	Found dead June 11	No microscopic examination made; specimen preserved.	

First series of experiments—*Inoculation with diphtheritic matter subcutaneously and in the mucous membrane of mouth*—Continued.

Number of experiment.	Date of inoculation.	Animal.	Place of inoculation.	Result.	Autopsy and microscopic examination.	Remarks.
33	May 24	Small black rabbit	With dry, fresh material in left thigh.	Died June 10	Blood from ear was examined May 29, and no micrococci found. Autopsy did not show anything abnormal. Death could not be accounted for. Microscopic examination of organs did not reveal micrococci in vessels of organs.	Matter taken from a fatal case (Dönges child).
34	May 24	do	do	Remained well		Do.
35	May 24	Large young rabbit	do	Died June 14	No micrococci in blood. Large cheesy lump at part of inoculation; lymphatic glands enlarged and cheesy. Tuberculosis? Nothing abnormal found.	Do.
36	May 31	Albino rabbit	With fresh, not dried, diphtheritic matter (from Dönges child) in left thigh.	Died June 4	Blood examined just before death shows blood crowded with micrococci in white blood corpuscles and free and single, and in zooglæa form. Large local pseudo-membrane.	Do.
37	May 31	Albino rabbit, young	do	Died June 5	Blood crowded with micrococci. White blood corpuscles; all loculated and full with micrococci.	Do.
38	May 31	Small gray rabbit	do	Died June 9	Some micrococci in blood, free and in white blood corpuscles and in zooglæa masses.	Do.
39	July 8, 8 a. m	Large steel-gray rabbit	Inoculated below skin of neck and into tonsils.	Found dying July 9, in the evening.	Wound of neck slightly sloughing. Autopsy immediately. Blood from jugular vein shows micrococci in nearly all white blood corpuscles, and some few micrococci free. No zooglæa masses. Tonsils and pharynx much inflamed and swollen and ulcerating, but not showing definite false membrane. Trachea and lung congested. Rest of organs appear normal. Microscopic examination of tonsils, spleen, and marrow of bone showed multitude of micrococci, but none or very few could be discovered in kidney and liver.	Membrane taken at the post mortem from a child at Blockley Hospital (Dr. Kollock's case). It was about 36 hours after death, and very stinking; weather very hot.
40	July 8, 8 a. m	Large yellow-brown buck rabbit.	do	Remained well	Was ill and did not take food, but recovered on third day. Blood exam-	Do.

41	July 8, 8 a. m ...	Middle-sized yellow rabbit.	Inoculated only below skin of left thigh.	Died July 10, afternoon.	ined July 9; did not show micrococci. Wound covered with false membrane. Blood contained micrococci in white blood corpuscles and free. Kidney, liver, and spleen showed micrococci emboli.	Do.
42	June 24.....	Large black and white rabbit.	Inserted about ten grains of solid, fresh diphtheritic matter below skin, back of right ear.	No result	A cheesy lump formed, but subsequently discharged and wound healed.	Diphtheritic matter fresh from a case of Dr. Montgomerry, but had been left soaking in water for 30 hours.
43	June 24.....	Large black rabbit.....	....do	....do.....	Wound healed perfectly.....	Do.
44	June 24.....	Small gray rabbit.....	....do	Died July 2.....	Large sloughing cheesy ulcer behind ear, right side of head, and the eye reddened and swollen, not unlike erysipelas. Tissue around lump full of micrococci and small bacilli. Blood showed micrococci in white blood corpuscles and a few zooglæa masses. Organs examined under microscope in sections for micrococci emboli, but none could be discovered.	Do.

In the table just given there are recorded forty-four experiments, in only fourteen of which the animal died unless killed accidentally or otherwise.

The time between the dates of death and of the last inoculation was: Experiment 4, six days; experiment 6, seventy hours; experiment 11, fifteen days; experiment 16, eleven days; experiment 23, thirteen days; experiment 25, two days; experiment 33, seventeen days; experiment 34, twenty-two days; experiment 36, four days; experiment 37, five days; experiment 38, nine days; experiment 39, one and a half days; experiment 41, two and a half days; experiment 44, eight days.

The question naturally arises as to whether the few animals in which the inoculation was followed by death died of diphtheria or of some other disease. Of these fatal cases there were only seven in which a strong suspicion of septic poison could fairly be entertained; death was too long delayed. In one of these, experiment 25, the animal died two days after the third inoculation, but it had been first inoculated fifty-two days previously, and was very tubercular; so that the last inoculation may have had nothing to do with the fatal result. In experiment 6, no bacteria were found except in the lungs; no false membrane existed anywhere; the lungs were full of hemorrhagic infarctions, and the peculiar, long-continued convulsions are not a symptom commonly seen in septic diseases of rabbits. There is, therefore, no proof that the rabbit died of diphtheria or of septic poisoning; it is probable that the wound of the larynx brought about the fatal result. Experiments 36, 37, 38 constitute a group of inoculations from one case in which there were very decided evidences of septicæmia in the rabbit both before and after death; the same statements apply to experiments 39, 41: omitting these two groups of fatal cases, we find that in only one of the fatal cases were there any exudations present in any organ which could give rise to the slightest suspicion that the animal died from diphtheria. In this case, experiment 16, there was only a catarrhal inflammation of trachea (with an exudation) which presented some of the characteristics of false membrane. In none of these cases were micrococci found in the blood. There is, therefore, little reason for believing that the rabbits died from diphtheria or even from septic poisoning. Of what, then, did they die?

A study of the post-mortem reports will show that in nearly every case the internal organs were tubercular, and in many cases intensely so; also, that tubercular disease was found in the organs of those rabbits which were killed some days after inoculation. It is, therefore, a very natural belief that in those cases in which death was long delayed it was due to tuberculosis. In order to discover whether the diphtheritic exudation acted specifically in the production of tubercle, or whether it merely set up a local inflammation which formed a focus of infection, we experimented by putting under the skin of rabbits small masses of innocuous foreign matters.

SECOND SERIES OF EXPERIMENTS.

Inoculation of foreign bodies subcutaneously.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
45	Apr. 19	Small rabbit, No. 16.	A piece of wood, fragment of a match, put below the skin in the posterior part of the neck and the wound closed by a suture.	Wound healed rapidly, but subsequently a small lump of cheesy matter was formed. The animal was feverish for several days. In the lapse of two weeks the lump disappeared, and the animal remained well to date, June 8.	.....	The foreign bodies used here have been before the experiments thoroughly washed and cleaned.
46	Apr. 22	Small albino rabbit, No. 17.	Treated similarly.....	Wound healed rapidly, but within a few days a large lump formed; ulceration set in, and cheesy matter protruded from wound; animal became emaciated, feverish. Died May 13.	All organs appeared hyperæmic; liver contains several small abscesses and numerous small nodules, the latter also seen in lung and spleen; lymphatic glands swollen; microscopic examination revealed large collections of tubercle granulations in all organs; the proportion of white blood corpuscle increased; no bacteria in blood.	
47	Apr. 22	Small rabbit, No. 18.	A piece of clean glass put below the skin in the right thigh; wound closed.	Result similar to last, only slower. Died May 20.	Lesions similar to the last, but slighter in degree; hemorrhagic infarctions in lungs very marked.	
48	Apr. 25	Large albino rabbit, No. 19.	A piece of glass put deep below the skin in the right thigh; wound closed.	Wound healed at first, then severe ulceration set in, cheesy matter protruding from wound; the latter increased to four times the original size. Died May 10.	No decided lesions to the naked eye; microscopic examinations showed all organs to be profusely tubercular; hemorrhagic infarctions in the lungs; echinococci cysts in the liver; no bacteria in the organs.	
49	Apr. 25	Albino rabbit, No. 20.	Treated similarly.....	Wound healed after slight suppuration. Animals remain well.		
50	Apr. 25	Small rabbit, No. 21.	Treated similarly with a piece of cork.			
51	Apr. 25	Small rabbit, No. 22.	Treated similarly with a small bunch of clean hair.			
52	May 6	Small rabbit, No. 23.	A piece of wood, fragment of a match, put deep below the skin in the right thigh.	Cheesy lump formed rapidly and protruded from wound. Died May 19.	All organs showed masses of tubercle granulations; no other decided lesion; no bacteria in the organs	
53	May 6	Small rabbit, No. 24.	A piece of wire put below skin in the left thigh.	Cheesy lump formed; the wire ulcerated away. Died May 15.	Hemorrhagic infarctions in lungs; tubercle granulations everywhere, although not very marked; no bacteria in the organs; none in the blood.	

It will be seen that in five out of nine of these experiments tubercle was found after death; this large proportion apparently demonstrates that a simple local inflammation may in the rabbit act as a source of tubercular infection. Now, when in our first experiments rabbits were inoculated with diphtheritic matter, inflammation was almost always induced at the seat of the lesion, with the formation of large lumps containing cheesy matter. These facts being so, it is a fair deduction that the tubercles were secondary to the local inflammatory foci, and were therefore an indirect and not a direct result of the inoculation.

These experiments seem to warrant the deduction that inoculation with materials taken from patients suffering from the endemic mild diphtheria of Philadelphia frequently produces a secondary or indirect tuberculosis in the rabbit, but very rarely, if ever, causes any disease in the rabbits comparable to diphtheria in man, or even any septic disorder; of course the experiments do not prove that malignant cases of diphtheria may not occur in Philadelphia and have different relations to inoculation. Indeed, the groups of experiments omitted from the discussion (Exp. 37 to 41, inclusive) prove that matter taken from malignant cases of endemic diphtheria does produce in rabbits a rapidly fatal disorder.

The method by which Trendelenburg asserts that he succeeded in producing diphtheria in rabbits consists in placing the exudation matter in the trachea. We naturally have suspected that the membrane when placed in the trachea produces simply a trachitis. This suspicion has been strengthened by the observation that acute pseudo-membranous trachitis and angina occur in rabbits. Such an epidemic destroyed, during the winter of 1879, a number of rabbits kept by one of us in a clean but damp place. The rabbits first showed sickness by refusing food; examination then detected swelling of the tonsils with exudation. There was a high fever with increase of the local symptoms until the animals became entirely unable to swallow. Death occurred in from three to seven days, preceded by great difficulty of breathing and profound exhaustion. False membrane was abundant in the mouth and trachea, and on examination showed all the characteristics of diphtheritic exudation.

In October, 1882, we observed a similar disease (spontaneous pseudo-membranous anigina and trachitis), from cause unknown, in white rats. Three out of seven animals died with very marked local lesions and the blood crowded with micrococci. The symptoms and phenomena of the disease were identical with those just described in the rabbit epidemic. The room in which the animals were kept in cages was very cold and draughty, but as well as the cages had been kept very clean and no diphtheritic material had been brought to the laboratory within three months. Six months previous these same rats had been inoculated with diphtheritic material, but had recovered and remained well until the time stated.

In order to determine whether the tracheal inoculation of rabbits with diphtheritic membrane taken from the mild type of the disease will cause pseudo-membranous trachitis, the following experiments were performed:

THIRD SERIES OF EXPERIMENTS.

Inoculation with diphtheritic matter in the trachea.

Number of experiment.	Date of inoculation.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
54	May 31.	Large albino rabbit, No. 27. Fresh rabbit.	Inoculated with dried diphtheritic matter, mixed with water, in the trachea, from without.	Recovered and remained well...	.....	Case X.—Of diphtheria, received through Dr. Jaggard, about 24 hours after removal. The membrane dry and hard; apparently in perfect condition.
55	June 1.	Albino rabbit, No. 10. See experiment 10.	Same as last	Died June 6, 5 days after inoculation, in convulsions.	External wound had healed perfectly; some ecchymosis noticeable, and the subcutaneous tissue infiltrated and congested. The wound in the trachea not quite healed; larynx and trachea congested and covered by a delicate true pseudo-membrane, which reaches, near the larynx, a thickness of 1mm. Microscopically, it also appears fully identical with the natural and with the ammonia false membrane, containing micrococci in large number. No bacteria in blood, none in organs. The organs are tubercular, more especially the liver, where large nodules can be seen even by the naked eye. No hyperæmia of organs, as in the ammonia specimen.	Same case.
56	June 14.	Young albino rabbit, No. 37.	Inoculated with dried diphtheritic matter, mixed with water in the trachea.	June 18. Evening. Animals apparently well; take food, &c.; breathing not much interfered with. The same evening killed rabbit 37; No. 38 was found dead June 19.	No lesions; no bacteria in blood, which was very carefully examined.	Case II.—Diphtheritic matter taken by Dr. Richard A. Cleeman from throat of patient untouched; inoculation about 36 hours after membrane was taken; it was dried quickly and was in good condition.
57	June 14.	Young albino rabbit, No. 38.	Same as last		No lesion; blood not examined.	Same as last.

These experiments show that the membrane of endemic diphtheria will produce a pseudo-membranous trachitis, and the question arises, is the pseudo-membrane proof of a specific trachitis, or is any trachitis of sufficient intensity acco panied by the formation of a false membrane? To answer this query the following experiments were undertaken:

FOURTH SERIES OF EXPERIMENTS.

Injection of ammonia into the trachea.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
58	May 15, 4 p. m.	Large albino rabbit, No. 11.	Injected three or four drops of aqua ammoniae into the trachea from without, the trachea being laid bare and a small opening cut into it.	Died May 18, 1 p. m., in convulsions, 69 hours after inoculation. During sickness breathing of the animal was extremely affected, very forced, deep, the rabbit opening the mouth widely at each straining effort, and raising the head; did not take food except the last twelve hours before death, when he seemed to feel easier.	Wound in skin and muscles covering the trachea was suppurating; tracheal wo nd had healed. All organs strongly hyperæmic, and tubercular nodules reeognizable by naked eye. On opening the larynx and trachea a well developed pseudo-membrane of 1 to 3mm in thickness was seen, which reached below the bifurcation and into the smaller bronchia. It resembles fully in color, consistency, and easiness of detachment, the natural croupous membrane, and is perfectly identical with the latter upon microscopic examination. Micrococci are abundant, both in spheres and disseminated; none in internal organs except the lungs. Tubercles in the lungs, spleen, lymphatic glands. Hemorrhagic infarction in lungs.	
59	May 15, 4 p. m.	Large albino rabbit, No. 12, about 4 years old.	Treated with ammonia similarly to the foregoing.	Died May 18, 4 p. m., 73 hours after inoculation. Animal seemed not to suffer and took food well; death in convulsions, which lasted about 3 hours.	External wound as well as that of the trachea had perfectly healed. Lesions perfectly similar to those of foregoing rabbit only less intense in degree. Tubercles more scarce; lungs less hyperæmic and less infarcted. No micrococci in blood; pseudo-membrane fully developed and perfectly similar to foregoing. Bacteria and micrococci present in membrane and in lungs, but none in other organs.	
60	May 28, 12 m.	Albino rabbit, No. 7.	Treated with ammonia like foregoing rabbits, experiments 58 and 59.	Died May 30, 11 a. m., 71 hours after operation.	Lesions fully identical with last rabbit, experiment 59.	
61	May 28, 12 m.	Cat, No. 7.....	Same as last experiments, 58, 59, and 60.	Died May 30, 2 p. m., 50 hours after operation.	Lesions and well-developed false membrane similar to those in the last three rabbits, but here absence of tubercles. No micrococci in blood, and none in organs.	

62	May 28, 12 m.	Dog, No. 3.....	Same as last.....	Great difficulty of breathing and inability to swallow followed the operation, but animal was artificially fed with milk, &c.; 12 days after the operation seemed to be recovering; killed June 9th.	Body much emaciated; skin wound healed, while tracheal wound was open yet; slight congestion of tissues around trachea. In many places on the mucous membrane of trachea traces of disappearing false membrane seen; whole trachea covered by thick tenacious mucus containing large quantity of luecocytes, some giant cells, and micrococci in moderate quantity. Spleen highly tubercular, tubercles in liver, lymphatic glands, and some in lungs. No micrococci in blood taken from jugular vein immediately after death.
63	June 8, 4.30 p. m.	Fresh rabbit, No. 25, about three months old.	Treated with ammonia similarly to foregoing five experiments.	Died June 9, 4 p. m.; no convulsions.	Autopsy made immediately after death. Wound in skin healed; tracheal wound open; the tissues around latter strongly hyperæmic; trachea nearly filled by false membrane. A preparation of menbrane taken five minutes after death showed the usual elements of a natural diphtheritic membrane with great abundance of micrococci; the blood did not contain micrococci. Lungs much congested; its vesicles largely filled with the croupous exudation, blood corpuscles, and micrococci. All other organs normal and not containing micrococci.
64	June 8, 4.30 p. m.	Rabbit, No. 26.	Same as last	Died immediately from effect of operation, too much ammonia having been given.	

The experiments which are recorded in the last table show that ammonia is able to produce in the cat and dog, as well as in the rabbit, a pseudo-membranous trachitis. Professor Oertel states that the membrane produced by cauterization of the trachea differs from diphtheritic membrane in containing no micrococci. What has led him to such an assertion, we cannot comprehend. In all our studies, when the death occurred very quickly, micrococci were somewhat less abundant in the traumatic membrane than in that taken from the throat of patients, but when the animal survived some days and the micrococci had sufficient time to develop themselves—when, in other words, they were afforded as good opportunity of growth as in the natural disease—they were immensely abundant, in some cases seeming to make up a large part of the bulk of the membrane.

A priori we would expect this result since we have demonstrated that there is no physical difference to be found between the micrococcus of the mouth and the micrococcus of diphtheria. When then, trachitis under the influence of the irritant, is set up and exudation poured out, it seems a necessity that the micrococcus shall rapidly spread in the soil thus provided for it. To see whether organic irritants other than diphtheritic exudations will produce a pseudo-membranous trachitis, the following experiments were performed:

FIFTH SERIES OF EXPERIMENTS.

Inoculation with foreign bodies, pus, &c., in the trachea.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
65	May 19.	Large rabbit, No. 14. See experiment 21.	Inoculated in the trachea with slough from a bed sore.	Wound healed rapidly, the animal recovering completely.		
66	June 3.	Small rabbit, No. 28. Fresh rabbit.	Inoculated in the trachea and in the thigh muscles with exudation from throat of a scarlet fever patient.	Died June 12	Large cheesy lump on thigh. Some congestion and translucent mucus around tracheal wound which had not healed; no false membrane. No lesions in the organs; not examined for bacteria.	Case X.—From Dr. Fulton, the matter being produce of ulceration of a scarletinal sore throat.
67	June 3.	Small rabbit, No. 29.	Inoculated in the trachea only with the same matter as last.	Died June 10	Skin wound healed; upon dissection a cheesy abscess found below subcutaneous tissue, pressing upon the trachea, and probably having been the cause of death. No other lesions perceptible. No bacteria in blood. None in organs.	
68	June 8.	Small rabbit, No. 30.	Inoculated in trachea with the pseudo-membrane produced by ammonia in rabbit No. 25.	Animal well, June 18		
69	June 8.	Small rabbit, No. 31.	Same as last	Killed June 16	No lesions except congestion of trachea and large cheesy lump between the trachea and skin.	
70	June 8.	Small rabbit, No. 32.	Inoculated in trachea with purulent mucus taken from trachea of dog No. 3, experiment 62.	Died June 11	No lesions in any organ perceptible; tracheal wound not healed. No bacteria in blood.	
71	June 9.	Large rabbit, No. 33.	Inoculated with ichorous pus in trachea.	Animal well		
72	June 10.	Small rabbit, No. 34.	Inoculated with pus in trachea.	Found dead June 11	No lesions except congestion of trachea.	
73	June 10.	Small rabbit, No. 35.	Same as last	Died June 18	Large cheesy lump between skin and trachea. Wound in trachea not healed; on opening the trachea a distinct pseudo-membrane of from 1 to 1½ millimeters in thickness was found, prominently seen only below the tracheal wound, *i. e.*, in the lower half of the trachea and the bifurcation. Microscopically, this membrane was identical with the	

Fifth series of experiments—*Inoculation with foreign bodies, pus, &c., in the trachea*—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Recovery or death.	Result of autopsy and microscopic examination.	Remarks.
					natural diphtheritic membrane and with those produced by introduction of ammonia, and of diphtheritic matter in the trachea. Cheesy abscess was found in the left lung; many air vesicles of both lungs filled with a croupous exudation containing multitudes of micrococci; prominent miliary tubercle in all organs. No micrococci in the kidneys; blood not examined.	
74	June 10	Small rabbit, No. 36.	Inoculated with ichorous pus in trachea, and also deep in muscle.	Died June 17.....	Large cheesy lump upon trachea, the latter much congested. Within the trachea a very distinct pseudo-membrane was developed having the same macroscopic and microscopic character, as that of last experiment. Croupous inflammation of lungs. Other organs normal.	

In looking over the last table, it will be seen that in two of the ten experiments pseudo-membranous trachitis was caused by the introduction of organic matter into the trachea. In both of the cases in which false membrane was produced the injected material was pus; and it will be noticed that only four such experiments were made, so that the proportion of successful result is very large; larger, indeed, than with true diphtheritic exudation in our experiments.

Trendelenburg found that not only ammonia, but also various other chemical irritants are capable of causing the formation of false membrane in the trachea. Many years since it was proven that tincture of cantharides will do the same thing. It would seem, therefore, that in the trachea the formation of a pseudo-membrane is not the result of any peculiar or specific process, but simply of an intense inflammation which may be produced by any irritant of sufficient power. The experiments so far detailed seem to establish the following propositions:

First. That it is difficult to produce in the rabbit a rapid septic disorder with the matter taken from ordinary cases of so-called diphtheria as we see them in Philadelphia.

Second. There are, however, certain malignant cases of diphtheria occurring in Philadelphia, inoculation with membrane from which produces rapid illness and death in the rabbit.

Third. That tracheal inoculations with membrane from endemic diphtheria will sometimes cause a pseudo-membranous trachitis.

Fourth. That both septic animal matter and non-organic irritants placed in the trachea cause pseudo-membranous trachitis which cannot be distinguished from diphtheritic trachitis, the membrane in both cases containing micrococci.

Fifth. The occurrence of a false membrane in the trachea is the result not of the specific character but of the intensity of the inflammation.

Section B.—EPIDEMIC DIPHTHERIA.

After studying the subject of endemic diphtheria, we next made trial of membrane from cases of the epidemic diseases. In the following report the membrane was obtained in experiments 75 to 89, inclusive, at Ludington; in the remainder, at Lakeview.

SIXTH SERIES OF EXPERIMENTS.

Inoculation with epidemic diptheritic matter from Ludington.

[The term "pyæmic abscess," used on several occasions, is meant to express a small collection of pus or cheesy matter made up of *débris*, cells, and micrococci not included in a cyst, with or without evidences of echinococci in them.]

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopic examination.	Remarks.
75	June 23.	Rabbit.....	In trachea with matter (from Roche case), material three days old.	Died June 26	*Autopsy one hour after death.*—A huge diphtheritic ulceration occupying whole front of neck. Trachea full of exudation, which extends to the pharynx, tonsils, roof of mouth, and back of tongue; exudation not very tough, full of micrococci; bone-marrow (examined fresh) filled with micrococci. Microscopic examination of organs showed—lung croupous pneumonia; liver and kidneys, cloudy swelling, with hemorrhagic infarctions, and only a few of the arterioles and capillaries blocked up with micrococci masses; spleen normal, and not containing micrococci.	The diphtheritic material was obtained at Ludington, patient died, and the inoculation made in Philadelphia.
76	June 23.	....do	.....do	Died June 27	Two hours before death, blood taken in tubes from the jugular coagulated instantly, and contained an enormous amount of micrococci. *Autopsy immediate.*—At place of wound around trachea, large ulceration filled with exudation, which was composed of leucocytes, fibrin and micrococci; mucous membrane of trachea inflamed; larynx filled with pseudo-membrane. The latter contained abundantly micrococci. Lungs, croupous pneumonia; rest of organs normal, and no micrococcus emboli after very careful examination.	
77	June 23.	....do	.....do	Died June 28	Blood examined after death full of micrococci; a large sloughing diphtheritic ulcer at seat of inoculation, with much exudation composed largely of micrococci, but containing numerous rod-bacteria also; trachea inflamed, containing very little exudation.	

					Double croupous pneumonia; also empyæma. Rest of organs normal. No micrococci could be discovered in any of the organs except in the air-vesicles of lung.
78	June 23.	....do	In vagina with diphtheritic matter.	Negative	
79	June 23.	....do	Diphtheritic material put into mouth and throat without scarification.	.....do	
80	June 23.	....do	Diphtheritic membrane from Smith's case, three days old, placed in pocket of muscle of thigh.	Died July 6.....	*Autopsy immediately after death.*—Blood full of micrococci; a large ulcer, with abundant diphtheritic exudation composed chiefly of micrococci, at seat of inoculation; liver full of small pyæmic abscesses (?). Marrow of bone full of micrococci. Kidney and liver contained some micrococcus embali; rest of organs normal.
81	June 23.	....do	.....do	Died June 26, seventy-one hours after inoculations. Blood from ear examined four hours before death contained micrococci, not very abundantly.	*Autopsy a few minutes after death.*—Blood from jugular vein full of micrococci. At seat of inoculation an almost gangrenous diphtheritic ulcer, surrounded by widespread œdema of subcutaneous cellular tissue; few pyæmic abscesses in liver; lung croupous pneumonia and some purulent pleurisy. Rest of organs normal, and not containing micrococci.
82	June 23.	....do	Diphtheritic membrane four days old (from case of Nelson) placed under skin.	Was sick, with periods of getting better, until July 11, when it died.	*Autopsy some hours after death.*—Blood contained no micrococci; did not coagulate rapidly; in no way perceptibly abnormal. At seat of inoculation a cheesy lump with micrococci. Liver with small pyæmic echinococci cysts filled with granular matter and pus; widespread tuberculosis of internal organs; no micrococci found in bone-marrow and spleen (which were examined).
83	June 23.	....do	Same mattter as last put in pharynx by scarification.	Negative	
84	June 23.	....do	Same matter as last put in eye; conjunctiva scarified and eyelids sewed up tightly.	At first considerable local inflammation about eye, which soon subsided; animal seemingly recovered, but was found dead July 16.	Liver with pyæmic abscesses; other organs normal and not containing micrococci.
85	June 23.	....do	A piece of diphtheritic kidney (from Roche case) 3 days old, inserted under skin.	June 30 rabbit very ill; died July 1.	Blood taken from jugular (June 30) by means of sealed tubes clotted at once, was full of micrococci. Autopsy some hours after death. Liver studded with pyæmic abscesses spleen swollen and dark; rest of organs normal, and in none of them could micrococci be discovered.

Inoculation with epidemic diphtheritic matter from Ludington—Continued.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopic examination.	Remarks.
86	June 23.	Rabbit.....	In trachea with matter (from Roche case), material three days old.	Died July 6	*Autopsy immediate.*—Blood full of micrococci; large diphtheritic ulcer at place of inoculation, with very profuse membranous exudation. Liver full of pyæmic abscesses. Organs not examined for micrococci.	
87	June 24.	... do	Hyperdermic injection of about three drops of blood taken four days before from a fatal case of diphtheria in Ludington.	Died July 3.....	No micrococci in blood. No lesions discovered elsewhere.	
88	June 24.	....do	.....do	Negative		
89	June 24.	....do	Injected 4 minims of saliva four days old.	Died July 11.....	*Autopsy.*—No micrococci in blood; no evidence of local lesion; internal organs slightly tubercular.	
90	March 10	Wild rabbit	Left thigh with fresh diphtheritic membrane.	Died March 14.....	Blood from jugular some time after death, loaded with micrococci, which were also abundant in spleen and marrow of bone. Large sloughing ulcer at seat of inoculation.	These inoculations were made at Lakeview, Michigan, immediately from the patient to the animal.
91	March 10	Guinea pig	Left thigh, fresh membrane.	Animal sick a few days but recovered.	.....	Same as last. Temperature taken daily during 10 days, at first varied somewhat but later was constant and never below normal.
92	March 11	Wild rabbit	.....do	Died March 14	Blood of heart full of micrococci. Spleen marrow of bone and kidneys also contain micrococci emboli.	The inoculation same as last.
93	March 11	White rat.....	Both thighs	Recovered.....	.....	Do.
94	March 17	....do	Thigh, dried membrane.....	.....do	.....	Do.

An examination of the records just given shows that the Ludington diphtheritic matter acted as a very deadly poison upon the animals inoculated with it. In three rabbits, portions of the membrane were placed in the trachea with uniformly fatal results (experiments 75, 76, 77). In three rabbits (experiments 80, 81, 82) the membrane placed under the skin or in the muscles acted as promptly as did that inserted in the trachea. The experiments in which the inoculation of membrane had no effect were those in which the poison was placed upon an open surface, where it was liable to be washed off. Such were experiments 78, 79, and 83, where the vagina and mouth were selected. In experiment 84 the membrane was more or less imperfectly retained in position by fastening the eyelid over it, and the result was somewhat doubtful.

In two instances (experiments 85, 86), instead of using membrane we employed minute pieces of kidney for inoculation, and with precisely the same effect, namely, rapid death, with characteristic lesions. Injections of minute quantities of blood and saliva into the veins (experiments 87, 88, 89) gave, however, entirely negative results, with one very doubtful exception.

The experiments made with the Lakeview material were not quite so decisive; out of five inoculations only two proved fatal, but these two were the only ones in which rabbits were used. In two others the animals were rats, which, in various other experiments, we have found to enjoy a singular immunity from being affected by the diphtheritic poison. In Europe it has been found that these animals are very slightly affected by any septic virus; and it would seem as though long-continued residence in sewers and similar places through successive generations has produced a power of resisting these organisms, which naturally are to be found in such localities. It ought further to be noted that the malignancy of the Ludington scourge was far greater than was that of the Lakeview epidemic.

It will be seen that the effects produced were entirely different from those which were obtained previously with Philadelphia matter. The result of the two series of experiments may be summed up in a few words, as in the following proposition: Whilst inoculation of the rabbit with false membrane from endemic or ordinary Philadelphia diphtheria is not usually followed by rapid systemic infection, it is so followed when the cases furnishing the false membrane have been malignant; further, the placing of material from cases of malignant epidemic diphtheria in the trachea or under the skin is usually fatal, the characteristic post mortem lesions consisting in the presence of micrococci in the blood, and sometimes also in the internal organs, along with severe inflammation at the point of injury, where there is produced an exudation resembling diphtheritic membrane and crowded with micrococci.

The question which naturally arises at the present juncture is: Is the affection produced in rabbits the same as diphtheria of man? Any one who has carefully studied the able, though not sufficiently known, pamphlet of Drs. Curtis and Satterthwaite will agree with us in believing that they obtained in some cases results similar to those which were yielded by the Ludington material, but in other instances effects like those produced with Philadelphia diphtheritic material. The portion of their text relating to this matter is so important that we quote it in full.

"In the above-described disease we failed to see anything specifically resembling diphtheria as it occurs in the human subject. The whole story seemed to be one of local-irritant poisoning, which always tended toward the production of an abscess at the site of inoculation, with greater or less concomitant hypodermic, ecchymoses, and serous infiltration of neighboring tissues, according to the degree of virulence of the inoculated poison. According, also, to the severity of the primary lesions, the animals would die or survive the immediate effects, and, according to the secondary history of the mass, infiltrated with leucocytes—according, namely, as the mass was reabsorbed or softened and ulcerated—the animal survived unaffected or slowly wasted away and died of exhaustion. But it might, not without reason, be argued that a rabbit is a widely different animal from a man, and that a disease induced by subcutaneous inoculation might naturally differ in its manifestations from the same occurring idiopathically; hence, that the described affection of rabbits might still be true diphtheria, although wanting in the specific characteristics of that disease as seen in the human subject. To determine this point we proceed to try if effects similar to the foregoing would follow the inoculation of a material resembling diphtheritic membrane in its anatomical and chemical character, but yet not only not diphtheritic, but even incapable of producing any noxious effect under circumstances where diphtheritic membrane often proves highly infectious. Such a material presented itself in the scrapings from the upper surface of a somewhat 'furred' tongue from a healthy person. These scrapings, while obviously not infectious when brought in contact with the pharyngeal mucous membrane, yet contain anatomical elements of similar character and in similar vital condition to those of the diphtheritic membrane. They also swarm with countless bacteria.

"Such scrapings, inodorous when fresh, acquire a peculiarly offensive, fœtid smell even within a few hours. Inoculations with this pulpy material were then made in the usual way, with the following results: Three animals were inoculated with the

matter freshly removed. Of these, one died between the fourth and fifth day with a lump in each thigh in all respects similar to that produced by the diphtheritic inoculation. One died on the fourteenth day, with similar lumps, which had softened and ulcerated; and the third on the twenty-fifth day, with widely extended burrowings of pus and secondary peritonitis. Four other rabbits were inoculated with tongue-scrapings twenty-four hours old and fœtid. Of these the first developed a large lump of the usual character in twenty-four hours. This was then removed entire for study, and the animal survived, with no further lesion. The other three animals were let alone; all developed the usual lesions, and all died on respectively the fifth, nineteenth, and twenty-fifth days. A third series of two rabbits were inoculated with the mixed scrapings of five successive mornings, which were exceedingly offensive to the smell. One died on the sixth day with the usual lumps, but as this was a young animal from a litter some of which died without having been experimented on at all, it is an open question whether or not the death in this case was due to the inoculation. In the other rabbit lumps developed, which ulcerated and discharged foul matter. The animal suffered also in its general health, but ultimately recovered.

These series of experiments thus developed the important fact that certain non-diphtheritic and non-infectious matters will, when inoculated upon the rabbit, produce a disease closely similar to, if not identical with, the disease caused by the inoculation of diphtheritic membrane, and one, also, equally fatal in its effects. But inasmuch as tongue-scrapings are open to the suspicion of containing some peculiar poison derived from the animal body, we determined to experiment with substance which should be free from such objection, while still resembling diphtheritic membrane and tongue-scrapings in the matter of being putrescent and swarming with bacteria. We accordingly chose Chon's fluid which had passed into a state of decomposition. This fluid is simply a solution in distilled water of ammonium tartrate, potassium phosphate, and magnesium sulphate, to which also a little calcium phosphate is added. Upon exposure in a warm place, bacteria appear in this fluid in great numbers, and of all the salts present new compounds are formed of a strongly putrid smell. Inoculations were made with this putrescent material, as follows: Two animals were inoculated in the usual way with the pulpy sediment forming at the bottom of the bottle and obtained by straining the fluid. Both developed the usual purulent lumps, but with little attendant irritation or constitutional disturbance. In both the lumps gradually disappeared by absorption and atrophy, and the animals survived. Four rabbits were inoculated by hypodermic injection with the lower stratum of liquid in another sample of the decomposed fluid. Lumps, as usual, formed at the site of each injection; one animal died on the tenth day; the other survived. Four rabbits were injected hypodermically with the upper stratum of liquid in still another sample. Lumps again appeared at each inoculated spot, but they were small, and all the animals survived.

"The same procedure in four other rabbits with a fourth sample of fluid produced like effects in three of the animals, but in the fourth no lumps discoverable by feeling the spot could be found. Fourteen animals in all were thus inoculated with the putrid Cohn's fluid. Thirteen of them developed lesions identical in appearance with the characteristic lesions from inoculations with diphtheritic membranes and tongue-scrapings, but the collateral effects were not so severe, and only one animal died from the effects of the inoculation. In short, then, putrid Cohn's fluid, inoculated upon the rabbit poisons after the same manner as diphtheritic membrane, though not to the same measure.

"It would seem, therefore, that the disease produced in the rabbit by inoculations of diphtheritic matter is not only not specifically diphtheritic in character, but not even peculiar to the diphtheritic infection, since a disease essentially similar, if it be not pathologically identical, is producible, though in variable intensity, by inoculations of material at once non-diphtheritic and non-infectious to human mucous membrane, and even, it may be, not of animal origin. This fact being apparently established, the important corollary follows, that pathological and pathogenetic conclusions drawn from the effects of diphtheritic inoculations of the rabbit do not, of necessity, apply to the disease, diphtheria, as it appears in the human subject. The many current hypotheses in the premises, therefore, which rest upon such animal experimentation are built upon a quicksand.

"This conclusion being accepted, it was plain that to attempt to elaborate the pathology of the diphtheritic process by study of the rabbit's inoculation disease would be a waste of time, and all thoughts of the same were accordingly abandoned. But though the inoculation disease is not necessarily nor even probably diphtheria, yet it is possible, and indeed probable, that the poisonous element in the diphtheritic membrane, which will produce diphtheritic infection in man, is the same kind of thing as that which produces the inoculation disease in the rabbit. Hence it seemed to us to be a useful research to try to discover the nature of the infecting principle, whether of diphtheritic membrane, tongue-scrapings, or Cohn's fluid, which produces the inoculation disease."

We give this extract in full because it seems to us very important, although we think there is no difficulty in showing the incorrectness of the conclusions reached; indeed, we believe that if the authors of the paragraph had had at their command facts now established, they would have arrived at different conclusions.

The fact that something else besides diphtheritic membrane will produce in the rabbit symptoms similar to those caused by the membrane does not disprove that the disease developed by the diphtheritic inoculation in the rabbit is diphtheria; it may be that putrid tongue-scrapings are capable of acting as a diphtheritic infective matter. In a previous chapter we showed that the micrococci of such tongue-scrapings are not distinguishable from those of diphtheria.

The most important objections to the conclusions drawn by Drs. Curtis and Satterthwaite are not, however, to be found in such reasoning as this. It is certain that in most cases the authors quoted failed to produce anything like diphtheria in the animal, and it is most probable that they never produced with Cohn's fluid anything more than a local inflammation. We have proven that almost any substance placed under the skin of the rabbit is capable of producing death, and that such death is preceded by the formation of cheesy lumps. The membrane of malignant diphtheria kills the rabbit rapidly without producing these lumps. Evidently the tongue-scrapings, &c., used by Curtis and Satterthwaite acted like the membrane from our Philadelphia cases, and did not cause true systemic infection.

On the other hand, if we examine the general constitutional symptoms exhibited by the systematically infected rabbit, we find they are a progressive failure of strength, with fever, such as are seen in the man suffering from diphtheria. If we examine the local symptoms the similarity is even more close; a membrane not to be distinguished by the microscope from that of diphtheria in the trachea, or if the inoculation has been made in the muscle, a local exudation similar in all its elements to this membrane. Drs. Curtis and Satterthwaite seem to rely upon the fact that in inoculated animals membranes do not form, except at the point of inoculation. We do not think this cogent. The cases of diphtheria in which membranes form elsewhere than at the original point of disease are certainly in the minority in man; and according to the best modern pathologists, it is probable that these secondary formations are the result of secondary local infections, and are not the direct result of the constitutional disturbance. Would any one deny that a case of disease in a child was diphtheria because membrane did not form elsewhere than in the throat?

Finally, the post-mortem lesions are not to be distinguished in the rabbit dead of an artificial diphtheritic trachitis and a child dead of a malignant diphtheritic trachitis. As, therefore, the poison is the same in the rabbit and in the man, as the symptoms induced are very similar and the post-mortem results identical, we are forced to believe that the disease produced by the inoculation of the rabbit with malignant diphtheritic membrane is essentially diphtheria.

Again, on page 101, we report some experiments which we have made to determine whether it is possible to pass the disease from rabbit to rabbit, and which show that the animal diphtheria does not differ from human diphtheria in its contagious power.

Further, there can be doubt of the spontaneous occurrence of diphtheritic epidemics among the lower animals. As examples of records of such, we would refer, *inter alia;* to the *Deutsche Zeitschrift f. Thierheilk*, 1877, III, p. 1; also, *Ibid*, 1878, p. 64, for very excellent studies of the affection as it occurs in calves, by Professor Dammann and by F. Blâzekovic; and to the *Marseilles Medical*, xvi, 1879, p. 104, for an account by Dr. W. Nicati of epidemics among pigeons. These and other articles we might cite are in accord with the studies made on rabbits and rats by Dr. Formad and prove that there is a contagious epidemic disease, which affects especially the young of domestic animals, and is exactly similar in its etiology, its clinical phenomena, and its post-mortem lesions to diphtheria in man. It is this disease, which we believe, that we have casued in our rabbits by inoculation. The *Experimentum crucis*, the absolute proof of the identity of human diphtheria with that of the lower animals would be its production by inoculating human belngs with membrane taken from diseased animals. For obvious reasons we have not made any such experiments, but we have found in medical literature several reported cases in which the production of human diphtheria has been ascribed to the animal virus.

The account of the first of these cases we know only as it is quoted by Mr. George Fleming, a veterinary inspector of the British war office (*Veterinary Journal*, 1881, p. 166), who states that a Mr. Macgilloray asserts that the disease (diphtheria) has been very common amongst calves in his practice for fifteen years, and that "isolated cases of sore throat often occur among farm servants, when ugly looking, yellowish spots or deposits are found in various parts of the throat."

Not having been able to obtain a copy of the original journal we are indebted to the New York Medical Record for the statement that Mr. Cole, a veterinary surgeon of Hinckling, in Australia, published in the *Australian Veterinary Journal*, February, 1882, a report on a severe epidemic of diphtheria amongst the lower animals, with 'an account of an epidemic (human) that occurred in the Oakleigh police station,

the disease being, on this occasion, traced to a diseased cow, whose milk had been used by the inmates of the station."

Mr. George Fleming (*Veterinary Journal*, September, 1881) is inclined to believe that the contagious disease known as "garget," or "infectious mammitis," in cows is a form of diphtheria. In 1879 a very violent outbreak of diphtheria in one of the London districts was officially investigated by Mr. W. H. Power, medical health inspector, who traced it to the milk supply, and came to the conclusion that the epidemic was due to the existence of "garget" among the cows (*Medical Times and Gazette*, January, 1879, p. 67). It is also stated in the journal just quoted, "that during the recent outbreak of diphtheria in the Princess May Home garget was found to be prevalent at the farm supplying milk to the home. We do not, however, attach very much weight to this evidence. It only has force enough to excite attention on the part of medical men having opportunities for observation as to the relations between the infectious mammitis and diphtheria.

Much the most decisive of the reported instances of the transmission of dipththeria from the lower animals to man is that which is detailed by Professor Dammann in the *Deutsche Zeitschrift für Thiermedicin*, 1877, III, p. 1. Professor Dammann's position as director of the Hannover Veterinary School, and the highly scientific careful method of his study and report of the epidemic give great weight and authority to his observations. The outbreak of the epidemic was among calves and the contagiousness of the disease was thoroughly established. At the suggestion of Professor Dammann, the veterinary officer in charge began, April 29, to make local applications to the mouths and throats of affected calves. On May 5, after some premonitory throat symptoms, he became ill, and four days later Professor Dammann found him confined to bed, with a high fever, complaining of very sore throat, great weakness, thirst, and cephalic distress; there was swelling of the cervical and submaxillary glands and slight membranous exudation upon the now highly inflammed tonsils; a day or two later, according to the report of his attending physician, the membrane in the throat became very well developed; subsequently the disease followed the usual course of a severe, but not malignant, diphtheria. The dairy maid, who took the place of the inspector in waiting upon the calves, was similarly but less severely affected. The origin of the outbreak among the calves could not be distinctly established, but it was traced with probability to the child of a coachman, who died of diphtheria at the hostelry before the first calf sickened.

We have, therefore, in the paper of Professor Dammann a clear record by a thoroughly competent observer of an epidemic of diphtheria in calves probably originating in man, and certainly spreading from animal to animal and from animal to man. This, taken with the other similar recorded cases and our own experimental facts, seems to us to establish the identity of human and animal diphtheria.

SEVENTH SERIES OF EXPERIMENTS.

Inoculation with diphtheritic products from animal to animal.

Number of experiment.	Date.	Animal	Inoculation.	Result.	Remarks, autopsy, and microscopic examination.
95	June 26	Rabbit	Piece of heart clot from rabbit No. 7 put under skin.	Died July 4	*Autopsy some hours after death.*—External wound healed, with small cheesy lump; no micrococci in blood; organs all tubercular.
96	June 27	do	Inoculated with false membrane from rabbit No. 2.	Died July 13	*Autopsy some hours after death.*—External wound healed, with very small cheesy lumps; organs tubercular; no micrococci in blood.
97	June 28	do	Put piece of membrane in jugular from rabbit No. 3.	Negative	
98	July 6	do	False membrane from rabbit No. 1 put in trachea.	Died July 9	*Autopsy two hours after death.*—Blood full of micrococci, also bone marrow; trachea with a moderate amount of pseudomembrane; lung croupous pneumonia and purulent empyæmia; spleen small, atrophied; liver with pyæmic abscesses; rest of organs normal and not containing micrococci.
99	July 6	do		Died July 14	*Autopsy.*—Large diphtheritic ulcer at point of inoculation, the slough containing all kinds of bacteria, but micrococci predominating; no micrococci in blood, spleen, or marrow of bone; no pyæmic abscesses in liver.
100	July 10, 9 a. m.	Albino rabbit	Hypodermic injection in back of blood of rabbit of experiment No. —, just dead of diphtheritic inoculation.	Found dying in the evening.	Profuse congestion at seat of lesion from the hypodermic injection. Blood full of micrococci in all forms (the blood used to kill this rabbit apparently was free from micrococci). Organs not examined.
101	July 10	do	do	Died July 11	Profuse local lesion; purulent cellulitis. Blood the same as in last experiment. Marrow of bone show micrococci and fine micrococci emboli in kidney and liver.
102	July 10	do	Same as last, blood from just dead rabbit.	Died July 16	Purulent local cellulitis. Micrococci in blood and in white blood corpuscles in moderate quantity. Organs not examined.
103	July 16	Small albino rabbit	do	No result	
104	July 16	Small gray rabbit	do	do	
105	July 16	Large black and white rabbit.	do	do	
106	March 14	Guinea pig	Inoculation in skin of neck with membrane from a pig died of diphtheria.	Died March 18	Sloughing wound. Blood full of micrococci. Organs not examined.
107	March 15	White rat	Inoculated in neck, with membrane from a pig as last.	Died March 20	Sloughing wound with abundant false membrane. Micrococci abundant in blood, which also contained a few bacilli. Marrow of bone and spleen crowded with micrococci.

These experiments certainly demonstrate that not only the local exudation but also the blood of animals dead of diphtheritic infection is capable of inducing similar infection in previously healthy animals. Those made with material originally from Ludington (experiments 95 to 99 inclusive) indicate that passing through the system of the rabbit lessens the activity of the poison, since in about half the cases tuberculosis and not acute systemic infection was produced. The remaining experiments of the series do not, however, accord with this, the animal virus showing itself to be very deadly.

The question now presents itself squarely before us, *What are the relations of the micrococci which exists in diphtheria to the disease? Are they the poison of the disease, or, in other words, are they capable of producing it?* The absolute final answer to this question can only be made by producing disease in the animal by micrococci isolated from the remainder of the diphtheritic poison. The difficulties to be overcome in such an attempt are very apparent. Three classes or lines of experiments at this juncture present themselves:

First. The study of the influence of filtration upon the poison as contained in the diphtheritic membrane.

Second. The study of the action of the isolated micrococci as they are to be obtained from urine.

Third. The study of the action of micrococci raised in culture chambers entirely away from the original poison.

Fourth. The effect of boiling upon the infectious properties of diphtheritic membrane.

In regard to the first of these methods, it is plain that the attempt must be to filter as completely as possible all solid particles from membrane, rubbed up with water; and also that if it be found that the filtrate is innocuous and the matter remaining on the filter still poisonous, the only logical deduction is that the poison is particulate and not soluble. It is impossible by this method alone to progress further and prove that the micrococci, and not the bits of fibrin, white blood cells, &c., are the *materies morbi.*

Drs. Satterthwaite and Curtis made an infusion of diphtheritic membrane and filtered it through a double paper filter. The filtrate, which was clear and odorless, was injected hypodermically into three rabbits. All survived, two without even any local lesion, but the third with a large lump of the usual character, containing living bacteria upon one side. None of the animals seemed to suffer in general health. At the same time the unfiltered infusion was injected into three other rabbits, and all of them died before the end of the third day with severe lesions.

It is evident that these experiments, as far as they go, indicate that filtration takes out the poisonous properties of diphtheritic material, since the formation of the lump in the side of one of the rabbits of the first series was due simply to local irritation. Want of material prevented Doctors Satterthwaite and Curtis from carrying this potionr of their research any further.

We have made a number of filtration experiments, using always the vacuum filter, sometimes forcing the liquid through porous clay cylinders such as are employed in certain galvanic batteries, sometimes drawing it through three or four thicknesses of filtering paper. The liquid for filtration was obtained by triturating the membrane with water. In some cases the membrane was allowed to macerate in the water for a few hours before the filtration.

The experiments are given in two tables, the first containing those in which the liquid filtrate was injected, the other those in which the solid matters left upon the filter were employed. A "syringeful" equals about half a fluid drachm.

EIGHTH SERIES OF EXPERIMENTS.

Experiments with liquid filtrate from diphtheritic matter.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopic examination.	Remarks.
108	May 31	Rabbit, moderate size...	Injected one drachm of the liquid hypodermically.	Died June 9.....	No local lesion except a little ecchymosis at place of injection beneath skin. No micrococci in blood, neither before nor after death. Organs normal. Death could not be accounted for.	Inoculated with a hypodermic syringe with liquid which had been filtered once through a clay filter; on microscopic examination no micrococci were found in the liquid but only a few bacterium termo. Fatal case (Döngós child). Matter fresh.
109	May 31	Albino rabbit.....	.....do	Died June 14.....	No micrococci in blood. Autopsy revealed right-sided heart clot but no lesion, except some decided congestion of all the internal organs. No cellulitis at place of injection.	Do.
110	May 31	Small black rabbit.....	.....do	Remained well.....	.....	Do.
111	June 24	Small Albino rabbit.....	Injected subcutaneously 10 minims of the diphtheritic liquid (clay filtrate).	No result	.....	Inoculated with liquid obtained by clay filtration of water in which membrane from (Dr. Montgomery) fatal case has been soaking 30 hours. Microscopic examination showed absence of micrococci; a very few rod bacteria to be seen.
112	June 24	Large gray buck rabbit.	Injected three syringefuls of the same liquid.	.....do	.....	Do.
113	June 24	Large black and white rabbit.	Injected two syringefuls of the same liquid filtrate.	Died July 10.....	Extensive cellulitis at seat of injection (back of neck). The œdematous liquid below the skin contained some micrococci. Blood also showed a few micrococci. A few white blood corpuscles contained them. Organs appeared normal; no microscopic examination was made of them.	

114	June 24	Small gray rabbit.....	Hypodermic injection of one syringeful of liquid clay filtrate.	No result	.....	Do.
115	June 24	Black French hare.....	.....do	.... do	.....	Do.
116	June 24	Wooly rabbit.....	Same as last, only dose increased to three syringefuls injected into different parts of the body.	.....do	.....	Do.
117	June 24	Albino middle-sized rabbit.	Same as last, two syringefuls.	Died July 1.....	Some cellulitis at seat of injection. Matter scraped off from seat of lesion showed some micrococci and some bacilli. Blood normal. Organs normal, except lungs highly congested.	Do.
118	June 24	Large gray and white rabbit.	.....do	No result	.....	Do.
119-24	July 8 10 a. m.	Six young French hares of one litter.	Each of these six hares was given hypodermically a syringeful of the clear clay filtrate above mentioned into muscle of right and left thigh.	Two of them found dying July 9, one died in the evening; two more were found dead July 10; one survived and remained well.	None of these five hares showed any micrococci in the blood or in the white blood corpuscles. There were some bacteria in the œdematous liquid at the inflamed cellular tissues at seat of the injection. Organs of one of those hares were saved and examined, but did not show micrococci or any lesions except some congestion. One of the hares showed peritonitis.	Inoculated with filtered liquid from membrane which was 36 hours old, dating from death, and was excessively stinking. Filtration through clay. No micrococci could be found in liquid, but only a few bacterium termo.
125	July 8	Gray rabbit	Two syringefuls of same liquid hypodermically.	Remained well.....	.....	Do.
126	July 8	Large Albino rabbit....	Hypodermically three syringefuls.	.....do	.....	Do.
127	July 8	Gray and white rabbit..	Same as last	Died July 25.....	Had several cheesy lumps below skin, furrowed by slight cellulitis; no œdema; no micrococci in blood, none in organs.	Do.

NINTH SERIES OF EXPERIMENTS.

Inoculation with solid residue from diphtheritic matter.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopic examination.	Remarks.
128	May 31	Rabbit of moderate size.	In right thigh	Died June 3.....	Micrococci in blood from ear one day before death; temperature at this time was 97° Fahr. (four degrees below normal). Blood crowded with micrococci and white blood corpuscles showed loculation and micrococci. Micrococci found also in marrow of bone and spleen. Sections of kidney and liver were made and stained with aniline, and numerous, micrococci emboli were discovered. The latter were better demonstrable in acid glycerine preparation.	Inoculated with solid matter (Dönge's child) left on clay filter.
129	May 31	Adult rabbit.....	In right thigh	Died June 4.....	Micrococci found in blood from ear on June 2, during life. After death blood showed also numerous micrococci, free and in zoogloea masses, and loculated white blood corpuscles. Organs showed micrococci emboli.	Do.
130	May 31	Small rabbit	.....do	.....do	Micrococci in blood; loculation of white blood corpuscles very marked. Organs showed some micrococci emboli.	Do.
131	July 9	Brown and yellow, large rabbit.	Inoculated in neck below skin and into trachea.	Died July 12.....	Diphtheritic pseudo-membranous trachitis and left-sided croupous pneumonia. Blood full of micrococci; also in white blood corpuscles, which are loculated. Kidney examined after hardening shows in sections numerous micrococci emboli. Rest of organs was not examined.	Solid matter which had been thoroughly rubbed up with water, and after this had been filtered off had been repeatedly washed on the filter with water. (Case of Dr. Kollock.)
132	July 9	Middle-sized gray rabbit.	Inoculated below skin of neck only.	Recovered	Wound healed perfectly	Do.
133	July 9	Middle sized gray and white rabbit.	Same as last, in left groin.	Found dying July 14....	Wound sloughing; pseudo-membranous lymphatic glands greatly swollen. Blood contains some micrococci in white blood corpuscles, but apparently now free. Spleen and kidney examined, but very few micrococci found. There were also some bacilli in the kidneys.	Do.
134	July 9	Large yellow rabbit	.....do	Recovered	Wound healed.....	Do.
135	July 9	Small French hare	Inoculated in muscle of back.	Remained well.....	.....do	Do.

In looking over these records of experiments it will be seen that there were 20 inoculations with filtered liquid and eight with solid materials, and that of the first series ten, or 50 per cent., died; whilst of the second series, five, or 60 per cent. of the inoculations resulted fatally. This at first sight indicates that filtration has but little effect upon diphtheritic matter, but a close study reveals a very different state of the case. In no case when a liquid filtrate was employed were there decided local evidences of diphtheritic inflammation at the seat of inoculation, and in no instance were there unmistakable signs of general systemic infection, such as abundant micrococci in the blood and internal organs; indeed in only a single instance were a few micrococci found in the blood, and even in this case the internal organs escaped. Several of the deaths were produced by secondary tuberculosis. Take these out and take out also the very fatal experiments made on July 8 (Exps. 119–124) and the deaths are reduced to a minimum. The cause of five out of six rabbits inoculated on July 8 (Exps. 119–124) dying so quickly is not clear, but points to the existence of some poison in the fluid used other than that of diphtheria. It must be remembered that the weather was intensely hot, that the membrane had been obtained in quantity at a post-mortem examination, and was in a state of partial decomposition, and that a large quantity of concentrated infusion was employed. Under these circumstances it is very probable that some alkaloidal or other soluble chemical poison was present in the stinking mass and rendered the infusion a deadly poison. However this may have been, it is plain the animal did not offer either the symptoms or lesions of diphtheria and did not die of diphtheria. Of course filtration does not remove absolutely all of the microscopic solid particles; a few will escape, and occasionally a filtrate may act feebly in producing the disease.

Further, when micrococci are so infrequent in a liquid microscopic examination may readily fail to detect them. When it is remembered that in no single case out of 20 experiments were distinct diphtheritic symptoms produced, although in one or two experiments a few micrococci developed at the point of injection, it seems to us that results more striking than we have obtained could not be expected. Control experiments show that in all instances the matter used was active; the water was brought in contact thoroughly with it and the amount injected into the animals was enormous. Moreover, in the control experiments it was proven that washing with water does not remove the poison from the solid mass. We must therefore consider it established that the poison of diphtheria is solid and particulate, and is not soluble in water.

As already stated in some detail in our biblographical review, Dr. Letzerich has found that if the clear urine of a patient suffering from diphtheria be run through paper filters, and these filters afterward washed so as to remove all possible soluble contaminating matter, and then dried, a paper is procured full of micrococci, but containing no other of the urinary elements except it be minute traces of epithelium, &c. The prepared paper Dr. Letzerich found to be as poisonous as is diphtheritic membrane.

In repeating these experiments of Dr. Letzerich we did not wash the filters before inoculation, so that our experiments may not seem to be as conclusive as they otherwise would be. When, however, it is remembered that the poison has been shown to be insoluble, solid, and particulate, and that it has been proven that water is unable to remove from diphtheritic material its noxious properties, the failure to wash the filter loses all importance.

TENTH SERIES OF EXPERIMENTS.

With filter taken from urine.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopical examinations.
136	June 23	Rabbit....	Vagina without erosion.	Negative.	
137	June 23	....do	Filter paper in mouth; scarified and tied up mouth.	Died June 25, about 36 hours after inoculation.	Autopsy some hours after death. Blood taken by tubes from the jugular vein full of micrococci in large numbers, both free and in zoogloea masses. No membrane in m. m. mouth, larynx, or trachea. Lungs pale and collapsed. Liver full of small abscesses. Other organs normal. No micrococcus emboli found in organs.
138	June 22	....do	Filter paper as last.	Negative.	
139	June 23	....do	Filter paper put under skin of thigh.	Died during night of June 25.	Autopsy some hours after death. Blood full of micrococci; white blood corpuscles full of micrococci; numerous balls of them in blood and zoogloea masses also. At seat of inoculation a sloughing ulcer covered with diphtheritic exudation with much œdema around it. Liver with pyæmic abscesses. Other organs normal and containing micrococcus emboli.

The experiments just reported show that the filter paper loaded with micrococci from the urine is even more poisonous than is the membrane itself. It will be remembered that in no case did we succeed in inoculating with the membrane placed in the mouth of the rabbit, yet one out of two experiments with the filter paper was successful. No vaginal inoculation with any kind of diphtheritic matter has in our hands succeeded, so that the failure of experiment 136 goes for nothing. In the only remaining trial the paper with the micrococcci was placed under the thigh, and death occurred in less than three days, the blood being crowded with micrococci and the internal organs markedly affected.

In order to determine whether ordinary urine contains any solid material poisonous to rabbits, we inoculated four of these animals with filter paper through which had been passed large quantities of normal urine. In one instance the paper was placed in the trachea through an artificial opening; in the other rabbits the pellets were put in the muscles. None of the rabbits were sickened. The tracheal wound healed rapidly.

The force of the urine-filter experiments seems to us very great. The amount of other solid particles in the urine was so small that it is very improbable that the particulate poisons which caused the diphtheria was other than the micrococci. As the experiments have been performed by three observers (Letzerich and ourselves), their correctness can scarcely be challenged. They seem to us to prove that the micrococci are either the poison, and by their growth enter the tissues and destroy the blood corpuscles, or else that they by the processes of growth in the body produce a poison which is the true *materies morbi*, or else that they are saturated with the poison and act as carriers of it.

Our next series of experiments were made to determine whether it is or is not possible to produce diphtheria with the artificially cultured micrococci. In them a piece of blotting-paper, which had been moistened with the culture fluid containing growing micrococci, was placed in the tissues or trachea of the rabbit. The experiments are as follows; those from experiment 140 to experiment 160, inclusive, were made in Philadelphia from cultivations of material obtained in Ludington; whilst experiment 161 to experiment 180, inclusive, were made at Lakeview from cultivations of fresh material:

ELEVENTH SERIES OF EXPERIMENTS.

Culture inoculations.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopical examinations.
140	August 8	Rabbit	First generation of micrococci from Ludington diphtheric matter in trachea.	Died August 9	Autopsy some hours after death. No micrococci in blood; no local or other lesions.
141	August 8	do	As last	Died August 23	Autopsy: Trachea healed; no micrococci in blood.
142	August 8	do	do	Died August 26	Blood examined just before death; no micrococci in it. Autopsy, pneumonia.
143	August 9	do	Fifth generation Ludington matter in thigh.	Died August 24	Autopsy some hours after death. No lesion in solid tissues; no micrococci in blood.
144	August 9	do	As last	Negative	
145	August 9	do	do	Died August 27	Autopsy: General tuberculosis.
146	August 9	do	do	Negative	
147	August 9	do	do	do	
148	August 9	do	do	do	
149	August 15	do	Inoculated in the muscle of the thigh with third generation, Ludington matter.	do	
150	August 15	do	do	do	
151	August 15	do	do	Died August 23	Autopsy some hours after death. No micrococci in blood.
152	August 15	do	do	Negative	
153	August 15	do	do	Died August 29	Autopsy some hours after death. General tuberculosis.
154	August 15	do	do	Negative	
155	August 15	do	Inoculated in trachea with third generation of Ludington matter.	do	
156	August 15	do	do	do	
157	August 15	do	do	Died August 17	Autopsy some hours after death. No micrococci in blood. Croupous pneumonia. No pseudo-membrane in trachea, but a simple catarrhal trachitis.
158	August 15	do	do	Died August 28	Autopsy: No micrococci in blood; croupous pneumonia; other organs normal.
159	August 15	do		Died August 28	Autopsy: No micrococci in blood; general tuberculosis.
160	July 13	do	Inoculated with the second generation of the diphtheritic matter in the thigh.	Died July 21	Blood examined just before death; contained micrococci in considerable quantity, infesting white blood corpuscles and also some free. Autopsy immediately. Filter-paper still in position surrounded by an inflamed area, but no pseudo-membrane. Liver does not contain abscesses; marrow of bone containing micrococci both in the cells and free; other organs congested, but no micrococci emboli.

An examination of the records of these experiments shows that there is only one in which it can be affirmed that diphtheria was produced by the inoculation with cultured micrococci. This was the experiment 160 made with the second generation. All the experiments made with the third and fourth generations failed, or at least yielded very doubtful results, in that after death no distinctive evidence could be found of the existence of false membrane at the place of inoculation or of micrococci in the blood. In experiment 160 the result was somewhat decisive. There is, however, a special reason why all the experiments, save the 160th should have proved unsuccessful. The diphtheritic matter was two and more weeks old at the time of inoculation, as our first studies were naturally directed to the morphology of the micrococci under culture. It will be shown later on in our memoir that the fungus must have lost some of its vitality; moreover, we allowed the individual generations of the cultures to grow longer than we should have done. Moved by these considerations and aided by the generosity of the National Board of Health, Dr. Formad went to Lakeview, Mich., and there made a series of cultures and inoculations. They are as follows:

ELEVENTH SERIES OF EXPERIMENTS—Continued.

Inoculation with cultures from Lakeview diphtheritic matter.

[Made in Ann Arbor, Mich.—Dr. Herdman's laboratory.]

Number of experiment.	Date.	Animal.	Inoculation and matter used.	Result.	Autopsy and microscopical examinations.	Remarks.
161	Mar. 19	Guinea pig No. 4	Hypodermic injection of culture liquid (10 minims) containing a pure crop of micrococci, 4th generation culture, 4 days' standing.	Died March 24.....	Micrococci in blood of heart. Extensive cellulitis with œdema at seat of inoculation. Organs showed micrococci emboli.	
162	Mar. 19	Guinea pig No. 5.....	Hypodermic injection of the same, into peritoneal cavity.	Died March 21.....	Micrococcoci in blood. Profuse purulent peritonitis. No examination of organs.	
163	Mar. 19	Middle-sized black rabbit.	Treated similar to Guinea pig No. 4.	.....	On immediate autopsy no micrococci could be found in blood. Profuse cellulitis at seat of inoculation and oedematous liquid containing large amount of micrococci.	
164	Mar. 11	Wild rabbit	Second generation of micrococci from case 2. Lakeview diphtheric matter.	Died March 16	Micrococci found everywhere in blood and organs. Sloughing wound.	Temperature fell below normal 12 hours before death.
165	Mar. 12	Wild rabbit	Third generation of micrococci from case 2, Lakeview diphtheric matter.	Died March 20	Cheesy lump at the seat of wound, with micrococci in tissue around it. Wound healed. No micrococci in blood, some in marrow.	Therm. observations daily, March 13 to 20: 102° F., 100°, 101°, 102¾°, 100°, 98°, 97°.
166	Mar. 10	Guinea pig	Second generation of micrococci from case 2, Lakeview diphtheric matter.	Found dead March 20	Micrococci in blood and everywhere in organs.	Therm. observations from March 11 till March 19, daily: 103½° F., 103°, 99°, 100°, 100°, 99½°, 97°, 99°, 96½° (on the day before death.) The animal sickened on the second day after inoculation.
167	Mar. 11	White rat	Second generation of micrococci from case 2, Lakeview diphtheric matter.	No result	Some local inflamation, which subsided soon	

Eleventh series of experiments—*Inoculation with cultures from Lakeview diphtheritic matter*—Continued.

Number of experiment.	Date.	Animal.	Inoculation and matter used.	Result.	Autopsy and microscopical examinations.	Remarks.
168	Mar. 11	White rat	Second generation of micrococci from case 2, Lakeview diphtheric matter.	Recovered	March 15, fine false membrane in the thigh	
169	Mar. 12	White rat	First generation of micrococci from case 2, Lakeview diphtheric matter.	Died March 18	At seat of inoculation much serous exudation with micrococci. Blood loaded with micrococci and bacilli.	Therm. observations from March 12 (evening) till March 18, daily: 102° F., 101°, 103½°, 104°, 93, 94½. Animal all the time ill, with much diarrhea last days.
170	Mar. 14	Guinea pig	Inoculation second generation, fresh-made and kept outside of incubator in cold place 4 hours.	Died March 18	Wound healed. No lesions or micrococci to be found anywhere.	
171–3	Mar. 15	Three white rats	Third generation	Negative		
174–5	Mar. 16	Two white rats	Liquid filtered away from second generation; it showed very few if any micrococci.	Negative		
176–8	Mar. 17	Three white rats	Inoculation with fourth generation.	Negative		
179	Mar. 17	White rabbit	Fluid filtered from second generation.	Died March 21	No local lesions. No micrococci in the blood, or other apparent cause for death.	
180	Mar. 17	Wild rabbit	Fourth generation hypodermically.	Negative		

Many of these experiments were made with rats, because it was very difficult to obtain the requisite supply of rabbits at Lakeview during Dr. Formad's visit to the place. At that time we did not know, what we have since abundantly proven, that rats are infected with diphtheritic poison only with difficulty. Dwelling in drains, sewers, outhouses, and similar positions for generations, the domestic rat seems to have acquired a power of resisting all septic organisms, as has been shown not only by our experience, but also by that of various European workers. In one of the experiments (169), however, the first generation of culture did produce a fatal diphtheritic infection, and in another case (experiment 168) the second generation caused a local inflammation, with formation of false membrane. Of experiments upon animals other than rats there are five in which diphtheritic symptoms and lesions were produced. The generations employed were from the first to the fourth. It will be seen, therefore, that in seven cases we have produced unmistakable results with cultivated micrococci, and that in several other instances have had evidences of infection, but that we have never been successful beyond the fourth generation.

It is true that in a number of cases we have failed to produce the disease; but this only rarely when the original stock was fresh. All of the experiments which were made at Lakeview are reported.

It has been established by the labors of Pasteur (address before the International Medical Congress, 1881) and others that fungal organisms are capable of losing their noxious powers under altered conditions of cultivation. For reasons which shall be detailed hereafter, we believe that this is eminently true of the micrococcus now under consideration. Failure, therefore, to produce diphtheria with the third generation of cultivated micrococci from old stock is no evidence that the micrococci is not the *materies morbi* of diphtheria. The explanation of such failure is probably to be found in the tendency of the micrococci to relapse into its inert stage or state under the more or less defective conditions of artificial cultivation. Then, again, we are convinced that quantity is a very important factor in the action of the diphtheritic micrococci; that not only must the plant be in an active state, but that also it must be in sufficient amount at the place of inoculation. The cultivated plant exists in very minute amount as compared with the natural plant, and in our culture inoculations the amount of the plant inserted into the animal was very small as compared with the mass inserted where membrane or kidney was employed. Whatever may be the cause of failure in some cases, it is certain that we have produced diphtheritic septicæmia with cultures up to the fifth generation.

It is evident that we have proven that the poison of diphtheria is solid and particulate; that it is found in the urine when the only solid particles present are micrococci, and it is producible by micrococci which have been grown entirely away from any animal organism. It seems to us established that micrococci cause diphtheria by their power of forcing their way into the tissues, and by their own excessive vitality overcoming the vitality of those tissues, changing their nutritive processes, destroying them, and finally getting into the blood itself, destroying its white corpuscles and obstructing the circulation; during this infective process it is very probable that the micrococci may by assisted by chemical principles, which are developed during the growth of the fungi, and which act as depressing poisons to the human system, although they are not the poison of diphtheria, and if existing by themselves in the blood would not cause diphtheria, but a general vital depression.

If the poison of diphtheria be, as we believe has been shown, micrococci, boiling the membrane for a length of time should deprive it of its noxious properties. The application of a temperature of 212° Fahr. may be endured for a short time by these lower organisms, and it is even possible that prolonged boiling may be withstood by some of them; but our present knowledge indicates that this is not the case. We have made a number of experiments as to the effect of high temperatures upon the toxic properties of diphtheritic membranes, and append an analysis of them:

SERIES TWELFTH.

Inoculations with boiled diphtheritic membrane, made at Lakeview.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopical examinations.	Observations of temperature, and remarks.
181	Mar. 11	Wild rabbit	In thigh, with membrane boiled for 5 minutes.	Found dead March 15	Micrococci in blood. Organs not examined.	Temperature of body 10 hours after inoculation: 102° Fahr.; March 12, 103½°; March 13, 101°.
182	Mar. 11	do	do	Animal found dead March 19.	Unhealthy ulcer showed micrococci. Micrococci in blood and marrow.	
183	Mar. 11	do	Second generation; boiled 5 minutes.	Found dead March 18	Sloughing unhealthy wound. Micrococci in blood in moderate quantity. No other lesions.	Thermometrical observations Mar. 12–18: 102° Fahr., 103°, 102½°, 100½°, 101°, 99°, 96½°.
184	Mar. 10	Guinea pig	Right thigh, with membrane boiled for 5 minutes.	Died March 17	False membrane in unhealed wound. A few micrococci in blood; more in marrow and spleen.	Thermometrical observations Mar. 10–16: 106° Fahr., 99°, 98°, 99°, 98°, 96°.
185	Mar. 11	White rat	Boiled membrane in thigh. The boiling was done in a test tube for 5 minutes.	Died March 19	Wound sloughing and gangrenous. Micrococci, and also motionless and movable bacilli, in blood. Kidney contained micrococci emboli.	Thermometrical observations daily March 11–18: 101° Fahr., 103°, 102½°, 104°, 99°, 100°, 97°, 98°.
186	Mar. 15	do	Boiled membrane from diphtheritic pig, boiled 15 minutes.	Recovered		This membrane culture chamber failed to show multiplication of micrococci.
187	Mar. 15	do	Boiled membrane for 15 minutes; inoculated in neck.	do		
188	Mar. 15	do	do	do		
189	Mar. 14	Guinea pig	Boiled pig membrane 15 minutes	Found dead March 19	Sloughing wound. No micrococci anywhere.	
190	Mar. 16	White rat	Membrane boiled 15 minutes	Negative		
191	Mar. 15	do	do	do		There was an abscess; this discharged and healed perfectly.
192	Mar. 19	Large white and gray rabbit, mother of the preceding litter of young rabbits.	Hypodermic injection of the liquid filtrate from matter used in last experiment.	do		
193	Mar. 19	Large Albino buck rabbit.	Fresh diphtheritic membrane from fatal case of diphtheria, boiled at a temperature of 107° for two hours in some water; after filtration through fourth filter paper, the residue, about 1 dram, was put below skin of neck.	do		

SERIES TWELFTH—Continued.

Inoculations with boiled diphtheritic membrane, made at Lakeview.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopical examinations.	Remarks.
194	Mar. 19	Guinea pig No. 1..	Fresh diphtheritic membrane from fatal case of diphtheria, boiled at a temperature of 107° for two hours in some water; after filtration through fourth filter paper, the residue, about 1 drum, was put below skin of neck.	Died March 22.....	.....	Death occurred while being shipped in a narrow cage from Ann Arbor, Mich., to Philadelphia. Autopsy could not be made.
195	Mar. 19	Guinea pig No. 2..	.....do	Negative	.....	Both animals alive yet.
196	Mar. 19	Guinea pig No. 3..	Treated similar as rabbit of experment.	.....do	.....	
197	Mar. 19	Young rabbit No. 1.	Hypodermic injection of ten minims of second generation of cultivated diphtheritic micrococci (of five days' standing, good pure crop), boiled for two hours at T. 107°.	.....do	.....	
198	Mar. 19	Young rabbit No. 2.	.....do	.....do	.....	
199	Mar. 19	Young rabbit No. 3.	The same with third generation (boiled).	.....do	.....	

SERIES THIRTEENTH.

Inoculations with boiled diphtheritic material from Philadelphia cases.

Number of experiment.	Date.	Animal.	Inoculation and material used.	Result.	Autopsy and microscopical examination.	Remarks.
200	July 8, 5 p. m...	Large albino rabbit...	Inoculated with boiled fresh diphtheritic matter into muscle of neck (large quantity of material employed).	Died July 20....	Wound covered with pseudo-membrane, sloughing. Blood contained moderate quantity of micrococci in white blood corpuscles and free. Organs contained beautiful micrococci emboli, but also some few bacilli.	The diphtheritic matter was obtained 36 hours post mortem (Blockley Hosp.; Dr. Kollock); boiled for 20 minutes in some water over spirit-lamp.
201	July 8	.....do	.....do	Recovered	.....	Wound healed perfectly.
202	July 8	Middle-sized albino rabbit.	Inoculated with same matter in left thigh.	....do	.....	Wound very soon healed.
203	July 8	Maltese rabbit.....	.....do	Died July 22....	Wound was cheesy, and sloughing extending into joint. Few micrococci in blood, some in marrow. Other organs not examined.	
204	July 8	.....do	Inoculated in muscle of back..	Negative	.....	Lesion was not observed.

On looking over this table it will be seen, first, that there were five experiments in which the diphtheritic material was boiled only five minutes, and that in each case death with abundant evidences of diphtheritic infection occurred, although in one instance the diphtheritic matter was a culture fluid. Second. That there were eighteen experiments in which the boiling was kept up for fifteen minutes or longer, and that in only one case (experiment 200) was there clear diphtheritic infection. In experiment 203 a few micrococci were found in the blood, but the wound was in a condition of cheesy rather than diphtheritic inflammation, and the case must be considered as one of very doubtful specific infection; in all these experiments (200 to 204, inclusive) a very large amount of material was put under the skin, and it was but natural to expect local trouble, even if the diphtheritic poison was destroyed. In the only other experiment open to any doubt (experiment 189) no micrococci could be found at the seat of the inoculation or in the blood, so that the death was, without reasonable doubt, the result of an unhealthy sloughing, but not specific, wound produced by the operation.

The first set of experiments of the present series show that exposure to a temperature of 212° F. for a few minutes is not sufficient to destroy the noxious powers of the diphtheritic poison, but the last set certainly indicate that the infective powers of the membrane do not survive a longer exposure, and the whole series warrants the conclusion that prolonged boiling destroys the infective properties of the diphtheritic membrane at the same time as it kills (see experiments 186, 187, 188) the micrococci. Of course this conclusion corroborates the theory that the micrococci are the *materies morbi*.

In all our experiments with diphtheria we have noticed that unless local symptoms are developed at the seat of the injection no systemic infection follows. The evidence we have brought forward certainly shows that usually diphtheria is primarily a local disease; we have made a few experiments in order to determine whether diphtheria is ever primarily constitutional, *i. e.*, whether the micrococci are capable of entering the blood at once before they effect a local lodgment and of sustaining themselves in the vital fluid so as to cause the disease.

SERIES FOURTEENTH.

Injection of fresh diphtheritic matter into the jugular vein.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy and microscopical examination.	Remarks.
205	July 8 ..	Large black and white rabbit.	Injected directly into jugular vein 10 grains of fresh diphtheritic matter rubbed with some salt solution.	Negative	....	The vein was exposed by dissection and subsequently ligated. Examining the matter before injection it showed a multitude of micrococci, granular *débris*, leucocytes, and degenerated epithelial cells. Wound healed and animal recovered.
206	July 8 ..	Large gray and white rabbit.	.....do	Found dying July 9, morning.	Wound beginning to slough. Blood showed moderate quantity of micrococci free and in the white blood corpuscles. Microscopic examination of organs showed micrococci emboli everywhere.	
207	July 8 ..	Large black and white rabbit.	.....do	Died July 14.....	Wound not healed and covered by enormous pseudo-membrane. Blood showed many loculated cells filled with micrococci, also zoogloea masses. Intense croupous pneumonia of both lower lobes. Marrow of bones and kidneys showed a few micrococci masses.	
208	July 8 ..	Middle sized brown rabbit.	.....do	Negative	.....	Wound healed.

These experiments are too few to be decisive, but, when taken with previous evidence, they are sufficient to show that the diphtheritic micrococcus is specially prone to produce a local before a general disease. In two of the experiments (experiments 205, 208) an enormous mass of active micrococci were injected directly into the blood and so swept into the torrent of the circulation that they could not make a local lodgment, and in both these experiments the animals survived. On the other hand, in two other experiments (experiments 206, 207), the same membrane having been used as in the other two experiments, the micrococci did get a local hold, and the animal died.

If these results be contrasted with those obtained with the poison of anthrax, in which the blood is the chief seat of the disease, the primarily local character of diphtheria becomes very apparent. We do not say that it is impossible in diphtheria for the blood to be primarily affected, but it seems to us very evident that such cases are rare and that the habit of the affection is to begin as a local disease. The practical import of this conclusion must be at once apparent to every one.

A very interesting accidental or natural, so to speak, experiment has come under our notice, which strongly confirms this view of the primarily local character of diphtheria. One of the families visited by Dr. Formad in Michigan lived in the woods in a rather isolated place. Nevertheless, four of the children suffered with the disease. The slops from the sick room were thrown out with the kitchen refuse and eaten by the pigs. One of these latter speedily sickened and in a few days died. An autopsy was made by Dr. Formad and the stomach with the lower end of the œsophagus was found in a state of intense inflammation and covered with a dense, very thick, false membrane, presenting all the macro- and microscopic appearance of a true diphtheritic exudation. It was simply loaded with micrococci. Moreover, the blood of the pig was full of micrococci both in zoogloœa masses and in the white cells, and micrococci emboli were found in the kidneys, spleen, &c. Further, in a number of experiments we produced fatal diphtheria in rabbits and other animals by inoculating them with material taken from the pig.

The pig undoubtedly died of gastric diphtheria, in which a local affection of the stomach produced a general systemic disorder.

A very important practical point to which we have paid some attention is as to whether diphtheritic matter loses its infective power. When we were working with the Ludington material our time was for some months so closely occupied with the more immediate necessities of our research that we were not able to make any experiments as to when the membrane begins to lose its activity; but the following experiments show that after a time the membrane, even if kept perfectly dry, does lose its contagious powers.

SERIES FIFTEENTH.

Inoculated with two months' old dry Ludington diphtheritic material.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Remarks, autopsy, and microscopical examinations.
	1882.				
209	Aug. 29	Rabbit....	Dried diphtheritic membrane in muscle.	Negative..	
210	Aug. 29	....do	.....do	....do	
211	Aug. 29	....do	.....do	... do	
212	Aug. 29	....do	.....do	....do	
213	Aug. 29	....do	.....do	....do	All these rabbits had been previously inoculated with culture plants.
214	Aug. 29	....do	.....do	....do	
215	Aug. 29	....do	.....do	....do	
216	Aug. 29	....do	.....do	....do	
217	Aug. 29	....do	.....do	....do	
218	Aug. 29	....do	.....do	....do	
219	Sept. 11	....do	Dried membrane in muscles.	....do	
220	Sept. 11	....do	Dried kidney in muscles....	....do	
221	Sept. 13	....do	Dried membrane in trachea		
222	Sept. 13	... do	.....do	Died October 1.	*Autopsy some hours after death.*—No micrococci in blood, no severe trachitis or any signs of pseudo-membrane; severe double pneumonia. Rest of organs normal and no micrococci found.
223	Sept. 13	....do	.....do	Negative..	The last four experiments were primary inoculations, *i e.*, rabbits had not been previously used.
224	Sept. 13	....do	.....do	Do.	

These experiments do not seem to need comment. The diphtheritic matter employed had originally possessed the most virulent properties. But in sixteen inoculations, four of them into the trachea, not once did it produce any signs of disease. On placing the micrococci in the culture chambers the reason of this was obvious—they had lost their power of rapid growth, and were as sluggish as plants taken from a furred tongue—a further evidence of the close connection between the power of growth of the micrococci and the infectious properties of the membrane containing them.

We have made a number of experiments with Lakeview membrane, which indicate that the loss of infective power is, at least, under some circumstances, very rapid. The dried membrane was only one or two weeks old. In original infective power we believe it did not compare with the Ludington membrane, which we found when recently dried to be very active.

SERIES FIFTEENTH—Continued.

Inoculation with dried Lakeview diphtheritic matter.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Remarks, autopsy and microscopical examination.
	1882.				
225	March 16	Large black rabbit.	Inserted into muscle of left buttock dried diphtheritic membrane.	Negative..	
226	March 16	Large mouse colored rabbit.	Inserted into trachea dried diphtheritic membrane.	Do.	
227	March 16	....do	.....do	....do	Breathing very labored and stridulous for two days, but ultimately recovered.
228	March 16	Large white rabbit.	..... do	Do.	
229	March 16	Large pepper and salt rabbit.	.....do	Do.	
230	March 25	Large Albino rabbit.	Inserted into muscle of left thigh dried diphtheritic membrane.	....do	Cheesy lumps formed.
231	March 25	....do	.....do	....do	Wound was sloughing for a while, then healed.

Before considering finally the nature of diphtheria, it seems proper to recapitulate the facts which have been demonstrated in this memoir.

Micrococci are an essential part of the diphtheritic process, being always found locally at the seat of inflammation, and, when blood poisoning develops, also in the blood, attacking and destroying the white blood corpuscles, forming emboli in the kidney, spleen, and other organs.

It is possible to produce in animals by inoculation with membrane, pieces of internal organs, urine, blood, &c., taken from persons suffering from diphtheria, a disease which offers during life the symptoms of diphtheria in man, and after death presents similar lesions, and which is also contagious—capable of reproducing itself; which we therefore consider to be diphtheria. Further, epidemics of diphtheria occur amongst the lower animals, and recorded cases by competent observers show that the diseased animals can produce diphtheria in man.

The poison of diphtheria is solid and particulate.

Washing the solid poison does not remove its toxic properties, and the filtered washings do not cause diphtheria.

The micrococci isolated in the urine or obtained by culture away from the body are capable of producing a systemic diphtheritic infection in the lower animals, if the local lesions develop of sufficient intensity.

Endemic and epidemic diphtheria are similar in their nature, but usually epidemic diphtheria is much more contagious than endemic, although endemic cases do occur possessing intense malignancy and contagious power.

The micrococci of diphtheria do not differ, so far as observed, from the micrococci of furred tongue, &c., except in their tendency to grow in culture fluids.

The micrococci of furred tongue or ordinary sore throat have a less tendency to grow under culture than have the micrococci of endemic non-malignant diphtheria.

The micrococci of endemic or non-malignant diphtheria have a much less tendency to grow under culture than have the micrococci of malignant diphtheria.

The rapidity of growth of the micrococci is in direct proportion to the malignancy of the case yielding them, and its contagiousness.

On exposure to the air diphtheritic membrane of the most virulent type loses its contagious power, and the micrococci *pari passu* lose their power of growing in culture fluids.

Under successive generations of artificial culture the diphtheritic micrococci lose their growth-activity, and also their power of infecting the rabbit.

It has not been experimentally directly proven, but it is a necessary inference from the two facts just stated, that under certain favoring circumstances the sluggish micrococcus puts on growth-activity, and, in all probability, poisonous properties.

Every grade of case can be found in man from an ordinary sore throat, through simple pseudo-membranous angina and trachitis, up to malignant diphtheria.

A case may begin as of sthenic "pseudo-membranous croup" and end as one of adynamic "diphtheria" with blood poisoning; and in cases of this character not infrequently no exposure to contagion is discoverable, and there is clinically every reason to believe that the blood poison has been developed within the body of the patient.

The theory of the disease which we would deduce from these facts is that the micrococcus, which causes the diphtheria, is not a specific organism different from that common to healthy and inflamed throats, but is an active state of that organism; that certain circumstances outside of the human body are capable of throwing this common micrococcus into the condition of active growth and engendering an epidemic of diphtheria. When diphtheria is thus epidemic, the micrococci light upon a throat and, if the throat have little resisting power, as in the child, inflame it or increase a catarrh already existing into a violent inflammation, and also rapidly enter the blood and cause systemic poisoning.

There is a divergence in opinion between the authors of this memoir in regard to the question whether the diphtheritic poison is capable of originating the local inflamation or must find an existing wound or catarrh as a nidus. Dr. Formad believes that the micrococcus can only obtain lodgment and produce the primary local sore when there is a lesion of the parts or an already excited inflamation. According to this view an attack of diphtheria must always be preceded by a simple catarrhal sore throat. Dr. Formad's opinion is founded upon the fact that in no case did we succeed in causing a diphtheritic inflamation by placing the diphtheritic false membrane upon an uninjured mucous membrane of the rabbit.

It is proper to state that our experiments were not made with any intention of testing this point; that those applicable to the question in which a malignant false membrane was used were only very few; and to the thought of Dr. H. C. Wood they only show that the mucous membrane of the rabbit has great resistive powers, and is not as easily inflamed as is the mucous membrane of the child's throat. In none of the experiments was the poison placed in the trachea, where the membrane is delicate and where the micrococci would be little apt to be washed away by secretion. Dr. Wood believes that this experimental negative evidence is of no avail against positive clinical evidence. He considers it absolutely certain that diphtheria is contagious, and if, as we have demonstrated, the micrococcus is the *materies morbi*, clinical facts prove that it is capable of inflaming a delicate throat in which no abrasion exists. Moreover, Dr. Wood believes that there is positive experimental evidence in favor of the view he holds. The case of the pig with gastric diphtheria is in point, since it is altogether improbable that there was any lesion of the stomach before the ingestion of the membrane. The animal was a healthy pig, showing no signs of accident or illness. Then, again, if we have had in regard to this point in a few experiments negative results, other experimenters have obtained an abundance of positive results. Letzerich in especial has succeeded in producing diphtheritic inflamation by placing false membrane upon uninjured mucous membranes, and Professor Dammann has succeeded in epidemic animal diphtheria in causing the disease by placing the membrane in the nostrils of calves. Dr. Wood believes, therefore, that the negative results we have obtained are due to imperfect experimentation; are opposed to positive results obtained by other observers, which positive results are in accord with an immense mass of clinical evidence, showing that the immediate cause of diphtheria is capable of infecting the system, not only by finding entrance through a wound, but also by inflaming a delicate mucous membrane having peculiar susceptibilities and low resistive power, and then, through the abundance of the exudate, causing necrosis of the superficial parts of this membrane and forcing its way through the thus opened lymph spaces in the manner previously explained.

Although the diphthertic attack produced by contagion is caused in this way by a microccocus from without, diphtheria may also be autogenetic. Thus, a catarrh

in a weakly subject may, in the beginning, be simply an inflammation from cold, but the ordinary micrococci in the throat or mouth, favored by the special conditions, *i. e.*, by the lowered resistive power of the diseased tissue, by the abundance of exudate, and by the increased local warmth, may gradually change from the dormant to the active state and by and by act upon the throat, and at last force their way into the system and a self-generated diphtheria be formed out of a "cold."

CHAPTER V.

ON THE RELATION OF DIPHTHERIA AND ITS MICROCOCCUS TO OTHER DISEASES.

The studies which we have made with the view of determining the relation of diphtheria and its micrococcus to other diseases have not been as complete as desirable, or as definite in their results. Nevertheless they do throw light upon the subject, and we offer them without reserve. They have been in two directions, *i. e.*, clinical examinations and experimental trials.

Examination of blood in measles, Philadelphia Hospital, spring, 1882.

Number of case.	Place.	Sex.	Age.	Day of disease.	Micrococci in blood.	Condition of blood.	Character of disease and termination.	Remarks.
1	Blockley Hospital, Philadelphia.	Male.....	2 years....	Third day.....	Micrococci in large quantity, free and zooglæa masses and infesting the white blood corpuscles.	White blood corpuscles in great excess and many of them loculated.	The eruption had disappeared, but child became daily worse.	The micrococci found in these cases were in every respect similar to those found in diphtheria, the same size and the same behavior to reagents and dyes.
				Ninth day	Micrococci increased in quantity.	The same.....	Child died in the evening of the same day.	Blood taken post-mortem from jugular vein showed multitudes of micrococci. No autopsy made.
2	...do	Female ...	2½ years...	Sixth day.....	Micrococci in blood free and in the cells.	White blood corpuscles in excess, mostly loculated and filled with micrococci. Red blood corpuscles do not form rouleaux.	Bad case; eruption most prominent in throat and mucous membrane; in general not much on skin.	
				Eighth day, three hours before death.	Same as last, only more.	The same.....	Died.....	Post-mortem, the micrococci appeared to constitute a part of the bulk of the heart's clot, which was very large and ante-mortem; organs, however, did not contain micrococci.
3		Male.....	2½ years...	Second day	No micrococci	Normal.....	High fever.....	Although this case was a typical one of measles, there was decided sore throat covered by pseudo-membrane.
				Fourth day	Blood full of micrococci, free and zooglæa masses and infecting some white blood corpuscles, but none are loculated.	White blood corpuscles increased in number. Red blood corpuscles fail to form rouleaux. Fibrin precipitating freely under the glass.	Worse.	
				Sixth day.....	Micrococci diminished in quantity and not affecting white blood corpuscles.	Same as before.....	Patient better.	
				Eighth day	Diminished in quantity.	White blood corpuscles and fibrin diminished.	Better.	
				Tenth day.....	Still less, but present yet.	Diminishing	.....do	Throat got well.

				Thirteenth day.	Some few micrococci seen, free and in short chains.	Blood nearly normal....	Doing well.	
				Eighteenth day.	No micrococci	Normal	Recovered.	
4	Blockley Hospital, Philadelphia.	Female ...	8 months..	Fifth day	Micrococci both free in blood and affecting profusely the white blood corpuscles, which are mostly loculated.	White blood corpuscles and fibrin in excess.	Bad case (died).....	Blood was examined only once. Child died on the ninth day. Large heart clot full of micrococci.
5	.....do	Male.....	4 years ...	Third day	A few micrococci seen in blood.	Normal	Apparently bad case.	
				Sixth day.	Micrococci increased in quantity, but none were noted to affect the white blood corpuscles.	Some increase in quantity of white blood corpuscles. No loculated cells. Red blood corpuscles form good rouleaux.	Child very low.....	Ulceration in mouth morbid in this case.
				Tenth day	Very few micrococci ...	White blood corpuscles diminished.	Doing well.....	Reported to have made good recovery.
6	.....do	Male.....	3 years....	Eighth day	Some micrococci, but only free and in zoogloea masses, none in white blood corpuscles.	Increase in white blood corpuscles and of fibrin.	Typical case.	
				Twelfth day	Micrococci disappeared.	Normal	Recovered.	

Twenty-three cases more of measles were examined; some once, others a number of times; but in none of these were any micrococci or any loculated cells discovered, although frequently staining and high magnifying lenses ($\frac{1}{12}$ Zeiss) were resorted to. All these cases are also known to have recovered perfectly. Eight cases of Rötheln (German measles) were also examined, but no micrococci found.

Examination of blood in erysipelas.

[Record of cases examined personally during the spring and summer of 1882.]

Number of case.	Place.	Sex.	Age.	Day of disease and when examined.	Quantity of micrococci.	Condition of white blood corpuscles and of blood in general.	Character and termination of disease.	Remarks.
1	Blockley Hospital, Philadelphia.	Male.....	40	Fifth day	Micrococci in large quantity, free and zoogloea masses, but none in white blood corpuscles.	White blood corpuscles decidedly increased in number. Blood highly coagulable.	Affection of leg. Great swelling and redness. Patient not suffering much.	
				Seventh day	Micrococci affect white blood corpuscles, some of latter being loculated.	The same.....	Patient doing well.	
				Ninth day	Very few micrococci, only free and in chains, none in the cells.	Blood nearly normal	Doing well.	Patient recovered.
2	....do	.... do	.....	Second day	No micrococci in blood taken from finger, micrococci in abundant quantity in some bloody serum taken directly from affected part; they were free and in zoogloea masses, and infesting some pus corpuscles.	Blood normal	Affection on face.....	
				Fourth day	No micrococci	The same.....	.....	The local lesion was rather slight.
				Seventh day	.....do	.....do	.....	Patient recovered.
3	....do	.... do	60	Sixth day	Enormous quantity of micrococci free, in zoogloea masses, and in the cells.	Nearly all white blood corpuscles loculated and infested by highly movable masses of micrococci.	Affection on scalp and face; patient shows pyæmic symptoms.	
				Seventh day....	Micrococci diminished in quantity.	White blood corpuscles increased in quantity, but only few affected.	Patient better.	
				Ninth day	Micrococci only few, free and in chains; none in white blood corpuscles.	Blood nearly normal	Doing well.....	There were numerous abscesses in scalp; but patient made ultimately good recovery.
4	....do	.... do	40	Fifth day	Micrococci abundant, free and in zoogloea masses.	White blood corpuscles in excess, but none loculated.	Affection of leg; quite extensive.	No more examinations in this case were made, but patient is known to have recovered.

5	do	Female	33	Fourth day	Some few micrococci, free, and also some white blood corpuscles affected.	Blood shows excess of white blood corpuscles and in highly coagulable state.	Facial erysipelas, bad case.	
				Eighth day	No micrococci	The same	Improving; discharged as cured on the 15th day.	Recovered.
6	do	do	25	Second day	No micrococci in blood. Some blood serum taken from the local lesion contained micrococci in abundance.	Blood normal	Severe case of facial erysipelas (left side).	Local lesion very extensive; the ear, eye, and the whole affected side of face is greatly swollen and discolored.
				Third day		do		
				Fifth day	Micrococci, free and in zoogloea masses, in blood, also numerous loculated cells containing micrococci.	White blood corpuscles enormously increased in quantity, and many are loculated.	Condition of patient worse. Delirium and other cerebral symptoms quite prominent.	The micrococci found here, as well as those of other cases of erysipelas, appeared perfectly identical with those occurring in diphtheria, in regard to size, shape, and behavior to aniline colors.
				Sixth day	Nearly all white blood corpuscles infested by micrococci.	Blood highly coagulable. Red blood corpuscles do not form rouleaux.	Condition worse.	
				Seventh day	Not examined		Died	Blood examined 12 hours; after death (from heart) showed enormous quantity of micrococci. Blood from finger showed only a few. Autopsy revealed also meningitis.
7	do	Male	50	Fourth day	No micrococci	Increase in white blood corpuscles.	Facial affection.	
				Seventh day	Some micrococci in zoogloea masses in blood.	A few of the white blood corpuscles infested by micrococci.	Patient doing well	Recovered.
8	do	do	42	Sixth day	Micrococci in blood, none in white blood corpuscles.	White blood corpuscles in excess.	Facial affection; doing well.	do.
9	do	do	32	Second day	No micrococci	Normal	Affection of foot.	
				Fifth day	Micrococci in moderate quantity in blood, none in white blood corpuscles.	do	Doing well.	do.
10	do	do	18	Fourth day	No micrococci	do	Affection of foot.	
11	do	do	26	Third day	Micrococci in moderate quantity.	White blood corpuscles in excess.	Facial affection; severe case.	
				Sixth day	Micrococci in abundance, but none in cells.	The same	Worse.	
				Eighth day	Micrococci less	do	Doing well	do.

Examination of blood in erysipelas—Continued.

Number of case.	Place.	Sex.	Age.	Day of disease and when examined.	Quantity of micrococci.	Condition of white blood corpuscles and of blood in general.	Character and termination of disease.	Remarks.
12	Blockley Hospital, Philadelphia.	Female ...	29	Third day	No micrococci	White blood corpuscles in excess.	Affection of leg; light case.	
	.....	.....	.....	Seventh day	No micrococci in blood of finger, but large amount of micrococci in serum taken from part affected.	White blood corpuscles not affected.		

Ten cases more of erysipelas were examined for micrococci; each case only once, three with positive and seven with negative results. All the latter were either very light cases, or else in an early stage of disease. The cases were lost sight of and termination unknown.

A study of the tables just given will show that there was examined for micrococci the blood of twenty-two cases of *erysipelas*. In thirteen of these the organisms were found in the blood, whilst in the other nine there were none. Of *measles* twenty-nine cases were studied; in six only were micrococci detected, whilst in eight cases of *Roetheln* or *German measles* there were no organisms. We have also investigated four cases of malignant fatal *scarlet fever*, in all of which we found the blood a few hours before death loaded with micrococci, both free, attacking the white corpuscles, and in zooglæa masses, and in one of which micrococci emboli were abundant in the kidneys. We have also studied four cases of "*puerperal fever*," probably *septic metritis*, in all of which micrococci existed in the blood before death.

It is very certain therefore that micrococci are not peculiar to diphtheria. The question which immediately presents itself at this juncture is, are the micrococci of these various diseases identical among themselves and with the plant that we have found to have etiological connection with diphtheria, or does each disease have its own specific micrococcus?

As already stated, it is very certain that there are no physical differences to be detected even with the highest powers of the microscope; nor is there any difference in the growth of the organisms, either in the blood of the living body or in the culture liquids of artificial propagation.

We have also tried staining with all chemical reagents that we have been able to procure; and the various micrococci have responded in no way different from one another. Of course, not being able to detect differences either physical or chemical, does not prove identity, since, as it is asserted that the specific character of these low organisms are chemical rather than physical, we cannot be certain that in the future some investigator will not discover a method which will determine differences not now to be perceived. All we can say, therefore, is that at present *no physical or chemical differences can be detected between the micrococci of various septic disorders.*

In order to discover, if possible, physiological distinctions, we have made a large number of experiments to determine whether the micrococci taken from erysipelatous affections produce in animals phenomena parallel to those caused by micrococcus diphtheriticus. These experiments are as follows:

Inoculation with fresh erysipelatous pus.

[From case of an iodiopathic erysipelas of face of old man with diffuse purulent cellulitis.]

Number of experiment.	Date.	Animal.	Seat of inoculation.	Result.	Autopsy and microscopical examinations and remarks.
232	May 23	Middle-sized black rabbit.	Inoculation in muscle of thigh	Died June 1	Wound sloughing. Blood contains abundance of micrococci, affecting mainly the white blood corpuscles. Organs congested and contain micrococci.
233	May 23	Middle-sized yellow rabbit.	do	Died June 6	Blood full of micrococci and many loculated cells filled with micrococci.
234	May 23	Brown rabbit	do	Recovered	Wound soon healed.
235	May 23	Middle-sized albino rabbit.	do	Died next day	No micrococci found.
236	May 23	Large albino rabbit	do	Found dying May 27	Some micrococci found as well as loculated white blood corpuscles.
237	May 23	do	do	Recovered	Wound healed.
238	May 23	Middle-sized albino rabbit.	do	do	Do.
239	June 6	Large albino rabbit	Inoculated in groin	Died June 12	Wound covered with large pseudo-membrane. Glands greatly swollen; cellulitis and large clouds of micrococci in surrounding tissues. Peritonitis. Organs contain micrococci, and nearly all white blood corpuscles are loculated and contain micrococci.
240	June 6	do	do	Died June 17	Wound as in last experiment, but contained only few micrococci. Organs not examined.
241	June 6	do	do	Recovered	Wound healed, although lymphatic glands remained swollen.
242	June 6	Large brown and yellow buck rabbit.	do	do	Wound healed, with encapsulated cheesy lump.

Inoculation from a case of diffuse cellulitis, or phlegmonous erysipelas of the leg.

Number of experiment.	Date.	Animal.	Seat of inoculation.	Result.	Autopsy, microscopical examination, and remarks.
243	June 6, morning	Large steel-gray rabbit.	Inoculated in muscle of back	Died June 6	Wound sloughing; great cellulitis around wound; micrococci in blood; white blood corpuscles largely affected; croupous pneumonia; micrococci in liver, spleen, kidney, and marrow of bones.
244	June 6	do	do	Died June 13	Wound covered with large pseudo-membrane; blood loaded with micrococci; most of the white blood corpuscles were loculated and filled with micrococci.
245	June 6	Large brown rabbit	do	Recovered	Wound had healed perfectly on fourth day; micrococci were present, but disappeared.
246	June 6	Large wooly white rabbit	do	do	Same as last.
247	June 6	Albino rabbit	do	do	Do.

Inoculation with fresh erysipelatous pus from a case of severe erysipelas of face and scalp, with formation of pus in cellular tissues of face and scalp.

[Blood contained micrococci.]

Number of experiment.	Date.	Animal.	Seat of inoculation.	Result.	Autopsy, microscopical examinations, and remarks.
248	July 26	Gray rabbit	Inoculations under skin behind left ear	Found dying July 28, evening.	July 27. Temperature 104½° Fahr., with sudden fall below normal in the morning before death. Great swelling and redness spreading over corresponding side of neck and head, resembling the human erysipelas. Tissues around place of injury were all found crowded with micrococci; blood considerably so. Organs all congested. Kidneys contained some few micrococci emboli.
249	July 26	Albino rabbit	do	Died July 31	Similar to last experiment, swelling of neck and scalp still more prominent. Micrococci present.
250	July 26	Gray and white rabbit	do	Recovered	Both had swelling of cellular tissues around wound, but when latter healed on fourth day it subsided. Micrococci, which were seen in the blood at that time, also disappeared gradually.
251	July 26	Gray rabbit	do	do	
252	July 26	Large brown buck rabbit	Inoculated in lower part of ear	Died July 28, evening.	Temperature on the 27th rose to 107.4°, and fell to 99° Fahr. six hours before death. Ear greatly swollen and inflammation spreading over face. Tissues around place of inoculation crowded with micrococci, also the blood. No micrococci could be found in organs.
253	July 26	Brown wooly rabbit	do	Recovered	Some swelling of the ear, which subsided on third day. Micrococci could not be found in blood.
254	July 26	Albino rabbit	do	do	Temperature rose to 106° Fahr., but soon subsided. At no time could any micrococci be discovered in the blood, which was examined a number of times.
255	July 26	Large albino rabbit	do	do	Wounds healed on second day, swelling subsided, and animals remained well.
256	July 26	do	do	do	
257	July 26	Gray and white rabbit	do	do	No inflammatory changes could be noticed at all.
258	July 26	Large albino rabbit	Inoculation in muscles of neck	Died July 31	Neck greatly swollen. Wound sloughing. Blood full of micrococci, affecting also the white blood corpuscles. Right-sided croupous pneumonia.
259	July 26	Albino rabbit	do	Recovered	Wound had healed perfectly. No micrococci found.
260	July 26	do	do	do	Same as last.
261	July 26	do	do	Died July 31	Blood show considerable quantity of micrococci in all forms of grouping. Organs not examined.
262 263 264	July 26	Albino rabbits	do	Recovered	Wounds had perfectly healed.

Inoculation with bloody pus from unhealthy diffuse cellulitis of calf.

Number of experiment.	Date.	Animal.	Seat of inoculation.	Result.	Autopsy, microscopical examinations, and remarks.
265	July 11	Large black and white rabbit.	Erysipelatous pus in muscle of thigh	Died July 14	Wound sloughing and covered with false membranes. Moderate quantity of micrococci in blood; organs did not show any.
266	July 11	Albino rabbit	do	Died July 13	Same as last.
267	July 11	do	do	do	Temperature rose to 105° Fahr. on July 12, and fell below normal on the day of death (20 hours). Blood full of micrococci. Organs congested, but did not show micrococci.
268	July 11	do	do	Died July 15	Same result.
269	July 11	Gray rabbit	do	Died July 18	Wound not healed. Blood full of micrococci.
270	July 11	do	do	Recovered	Particular attention was paid to the wounds, and they were found perfectly healed.
271	July 11	Albino rabbit	do	do	
272	July 11	Large albino rabbit	do	Died July 19, evening.	Micrococci could not be discovered until the fourth day after inoculation, when they began to affect the white blood corpuscles. Wound did not heal; was slightly sloughing. Temperature at first rose, on second day to 104°, and fell to 99° Fahr. on the day of death. (Average normal temperature of rabbits is 101½° Fahr.) Organs deeply congested, particularly kidneys, and the latter full of micrococci emboli.
273	July 11	do	do	Died July 14	On the 12th the temperature had suddenly risen to 106° Fahr., and fell before death. Blood was loaded with micrococci, which did not appear to affect the white blood corpuscles.
274	July 11	Gray rabbit	do	do	Animal, when died, showed temperature 104½° Fahr. No micrococci could be discovered in blood, and none in organs. Wound was healing rapidly. Death could not be accounted for.
275	July 11	Large albino rabbit	do	Died July 13	Microscopic examination of the pus before used showed it to be made up of leucocytes, red blood corpuscles, granule cells, fibrin, and micrococci in enormous quantity. Blood examined post-mortem; full of micrococci, affecting also white blood corpuscles. Organs not examined.
276	July 11	Large brown rabbit	do	Recovered	Wound in all these instances had healed perfectly within ten days, and when reopened showed a small cheesy lump, and surrounded by dense inflammatory tissue. Micrococci were observed at different periods, but not affecting the white blood corpuscles.
277	July 11	Small brown rabbit	do	do	
278	July 11	Large wooly rabbit	do	do	
279	July 11	Albino rabbit	do	Died July 18, evening.	Micrococci were found during life from third day on. Later examination from fifth day on showed white blood corpuscles affected. Wound did not heal; was sloughing. Organs not sound; they all were deeply congested.
280	July 11	Large black and white rabbit.	do	Died July 19	

There are reported in the series of tables just given the results of thirty-three inoculations made with pus of a most unhealthy character. In twenty-one instances death, preceded by the presence of micrococci in the blood, resulted; and in several instances the animal was very sick, but eventually recovered, the blood during the period of illness containing organisms which disappeared as the symptoms abated.

It is perfectly evident, therefore, that the unhealthy pus of erysipelatous cellulitis not only contains a micrococcus which exactly resembles that present in diphtheria, but also produces, when introduced into an animal, results, both local and general, similar to those caused by the inoculation of diphtheritic membrane.

A point which is worthy of attention is that when pus was employed from idiopathic erysipelas of the face the local effects resembled erysipelatous inflammation, rather than diphtheritic, a diffuse swelling being caused, and a general slough rather than a false membrane. This difference, however, is hardly constant.

We have also made several inoculations with material taken from a case of what might be termed hospital gangrene, as follows:

Inoculation with gangrenous matter.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Remarks.
281	Aug. 28	Rabbit.....	Inoculated in trachea with matter taken from a case of spreading gangrene, which destroyed the foot of a man in the Philadelphia hospital; it was full of micrococci.	Died Sept. 2, after suffering 2 days with severe trachitis.	Blood full of micrococci indistinguishable from those of diphtheria; inflammation of trachea with false membrane; liver full of collections of micrococci; other organs not examined microscopically.
282	Aug. 28	....do	As the last	Rabbit was ill, but recovered.	

These experiments seem to show that this so-called spreading or hospital gangrene is capable of producing in the rabbit symptoms and lesions similar to those caused by diphtheritic exudation.

In order to probe the matter more deeply we have made experiments with reinoculations.

Inoculations with slough from local pseudo-membrane produced in rabbit which died from inoculation with erysipelatous pus.

Number of experiment.	Date.	Animal.	Inoculation.	Result.	Autopsy, microscopical examinations, and remarks.
283	1882. June 2	Large rabbit..	Inoculation in side of neck; slough from another rabbit, Exp. 232.	Was in dying condition when killed, May 5.	Pseudo-membrane in wound. Blood examined just before death showed a few zoogłœa masses of micrococci, marrow of bones contained micrococci in moderate quantity.
284	June 2	Albino rabbit.	In left hind leg, same as last.	Died May 5 ...	No micrococci in blood; otherwise same as last.
285	June 2	Large rabbit..	Inoculation in back...	Found dying, and was killed May 5.	Blood examined immediately after death; did not show micrococci; the marrow of bone contained a moderate quantity of micrococci; distinct pseudo-membrane at seat of inoculation; micrococci in liver and kidneys.
286	June 11	Young albino rabbit.	Inoculated with matter from rabbit Exp. 239 in back.	Died May 17 ..	Micrococci in blood in cells and free; local lesion perfect; micrococci in kidneys.
287	June 11	Gray rabbit, moderate size.	Inoculated in thigh ...	Died May 16..	Same as last.
288	June 11	Small black rabbit.	Same as last	....do	Do.

These six experiments are abundantly sufficient to show that the micrococcus present in the pus of diffuse cellulitis does not lose its power by passing through the system of the rabbit, and that the membrane it invokes at the seat of inoculation is possessed of a deadly virulency.

The facts which have been established in the present research prove that the micrococcus of sloughing wounds, and of the so-called phlegmenous erysipelas, agrees in its physical, chemical, and pathological properties with that of diphtheria.

As we have submitted *Micrococcus septicus* and *M. diphtheriticus* to all known tests, optical, chemical, and vital, and found them always to respond alike, we conclude that the two organisms are specifically one, and that diphtheria is a septic sore throat, or is simply what it was called a century ago, *putrid sore throat, with or without a secondary constitutional septicæmia.*

The exceedingly pressing question whether the micrococci we have found in malignant measles, scarlatina, puerperal fever, &c., is the *M. septicus*, we are not prepared to answer positively. We have not practiced inoculation upon the lower animals, but the microscope and chemical reagents certainly indicate an identity. There is an explanation of the known facts which we offer with reserve as probable, though not positively proven.

In our examinations of the blood in the various diseases under discussion, we have never detected the micrococci before the second day of severe illness, and very rarely before the fourth day. We think that we have proven that the *M. septicus* is always about the human body in an inert state. It is very possible that in the conditions of vital depression and diseased secretions such as occur during low fevers, the organism finds the conditions for its development, and commencing to grow invades the system and produces a secondary blood-poisoning or septicæmia. This theory gains in plausibility when it is borne in mind that in scarlet fever, measles, and puerperal fever, the diseases which we studied, there are local foci of inflammation in which all the conditions are present for the urging of the micrococcus into growth and malignancy. There is no anatomical difference between a scarlatina sore throat and that of true diphtheria; the micrococcus is as abundant in the scarlatinal exudate as it is in the diphtheritic, and what we know of its life history shows that it must, under such circumstances, develop and invade the system. In malignant measles there are severe catarrhal inflammations; in erysipelatous cellulitis abundant local foci. It is therefore extremely probable, from the facts we have been able to establish, that secondary esoteric septicæmias are exceedingly important in the history of various diseases, and that often the patient dies, not directly from the original disorder, but from the secondary septicæmia it has brought about.

APPENDIX B.

ON THE SIPHONAGE OF TRAPS.

1. **REPORT OF COL. GEORGE E. WARING, Jr.**
2. **REPORT OF E. S. PHILBRICK, C. E., AND E. W. BOWDITCH, SANITARY ENGINEER.**

EXPERIMENTS UPON THE SIPHONAGE OF TRAPS.

[Made under direction of Col. GEORGE E. WARING, jr., for the National Board of Health.]

Appended to this report are the following drawings, viz:

1. Apparatus used in Experiments I to VII.
2. Manner of extending soil-pipe at top.
3. Anti-siphoning, 4 by 2 inch Y branch.
4. Manner of discharging contentsof water-closet bowl.
5. Common S trap of glass.
6. Bower's trap.
7. Garland's trap.
8. Brandeis' "Paragon" trap.
9. Nicholson's mercury seal-trap.
10. Apparatus used in Experiment VIII.

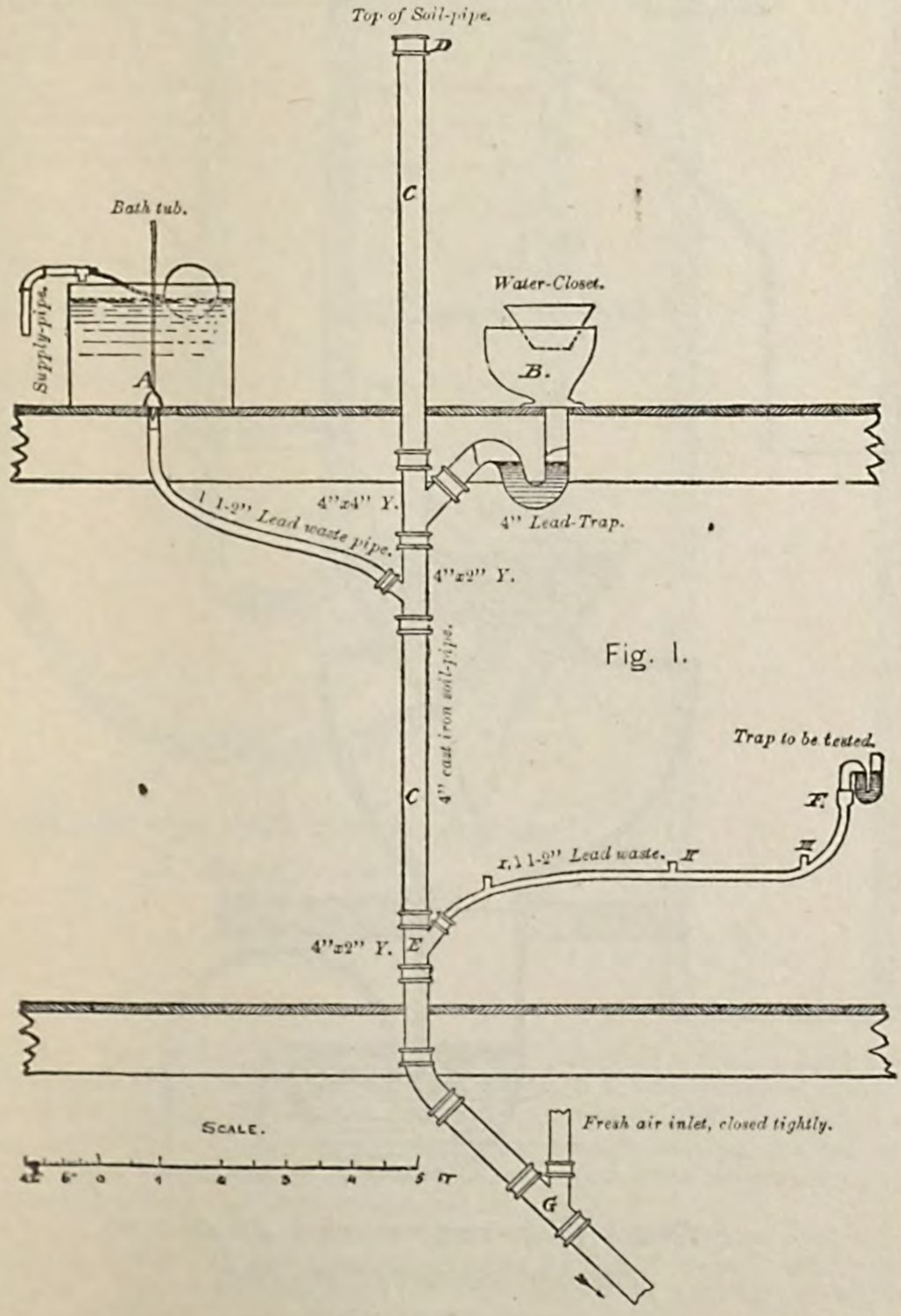


Fig. 1.

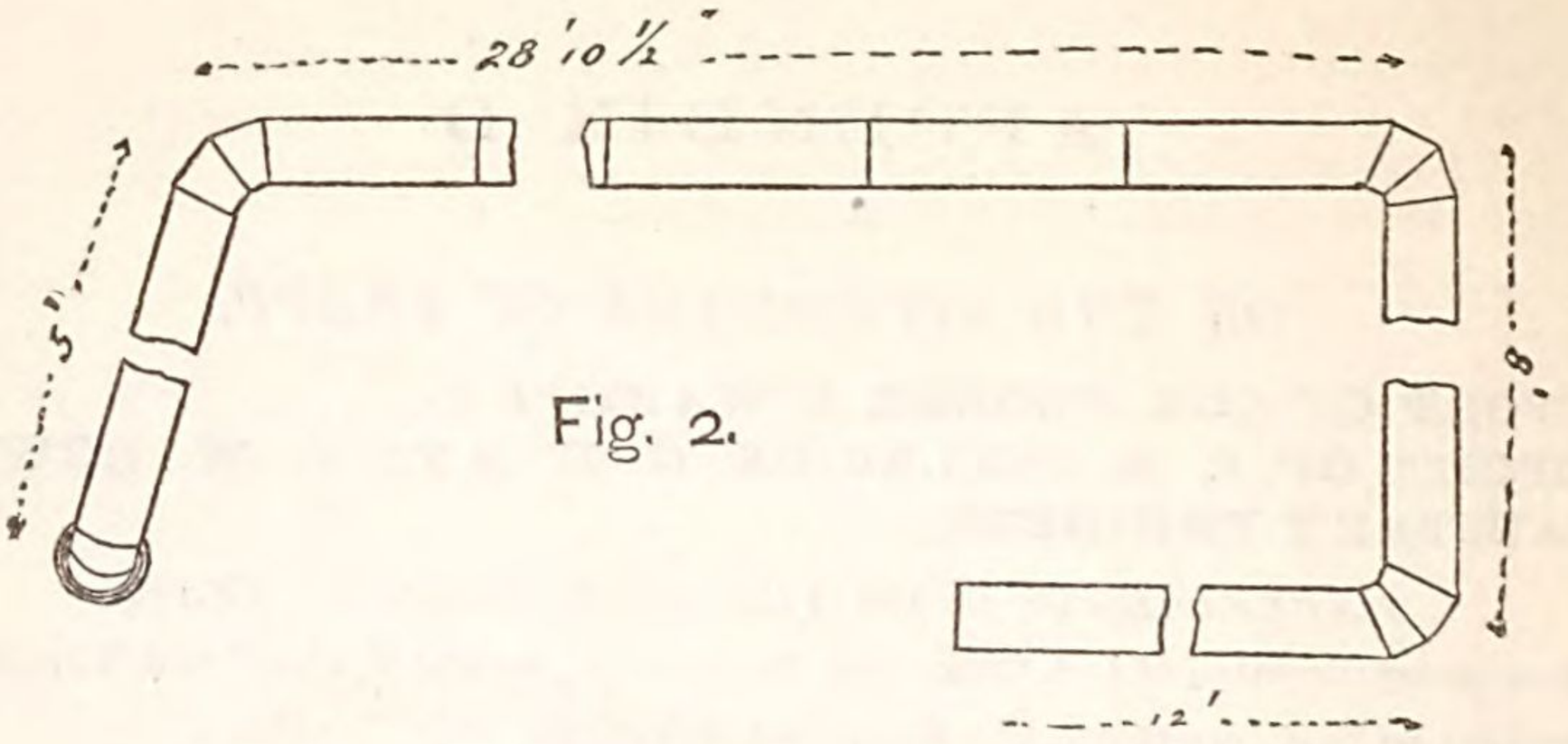


Fig. 2.

Sketch showing manner of lengthening soil-pipe at top.

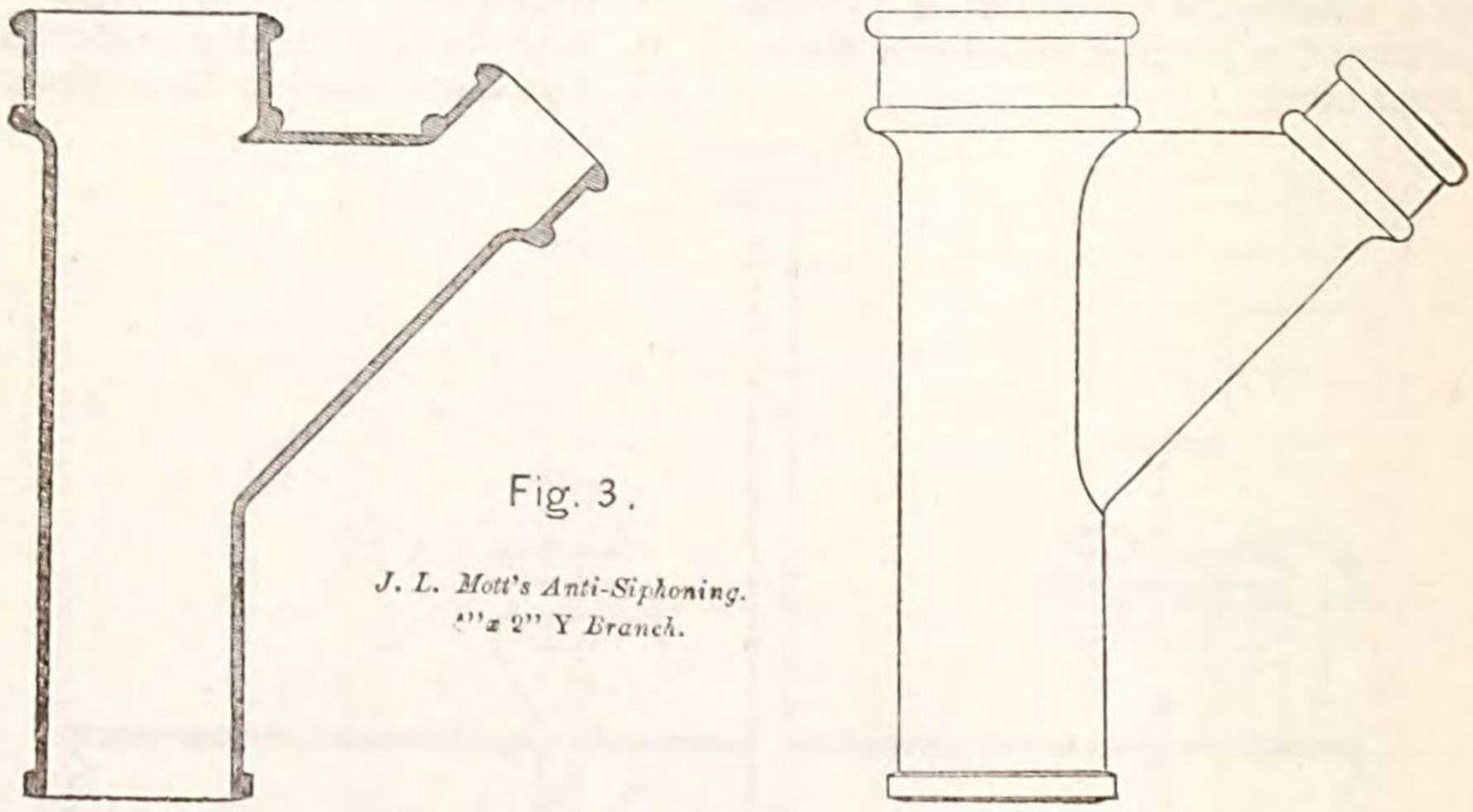
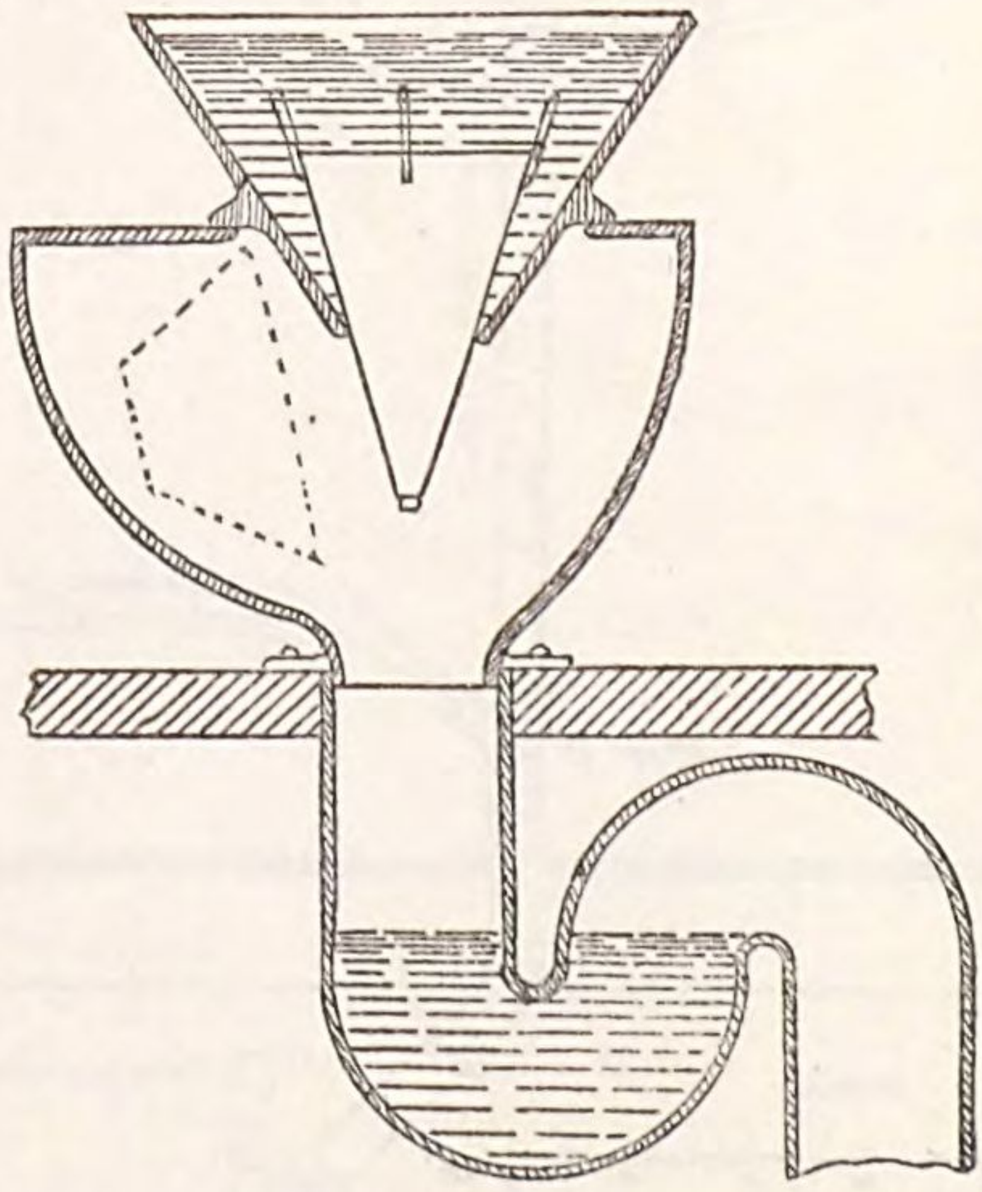


Fig. 3.

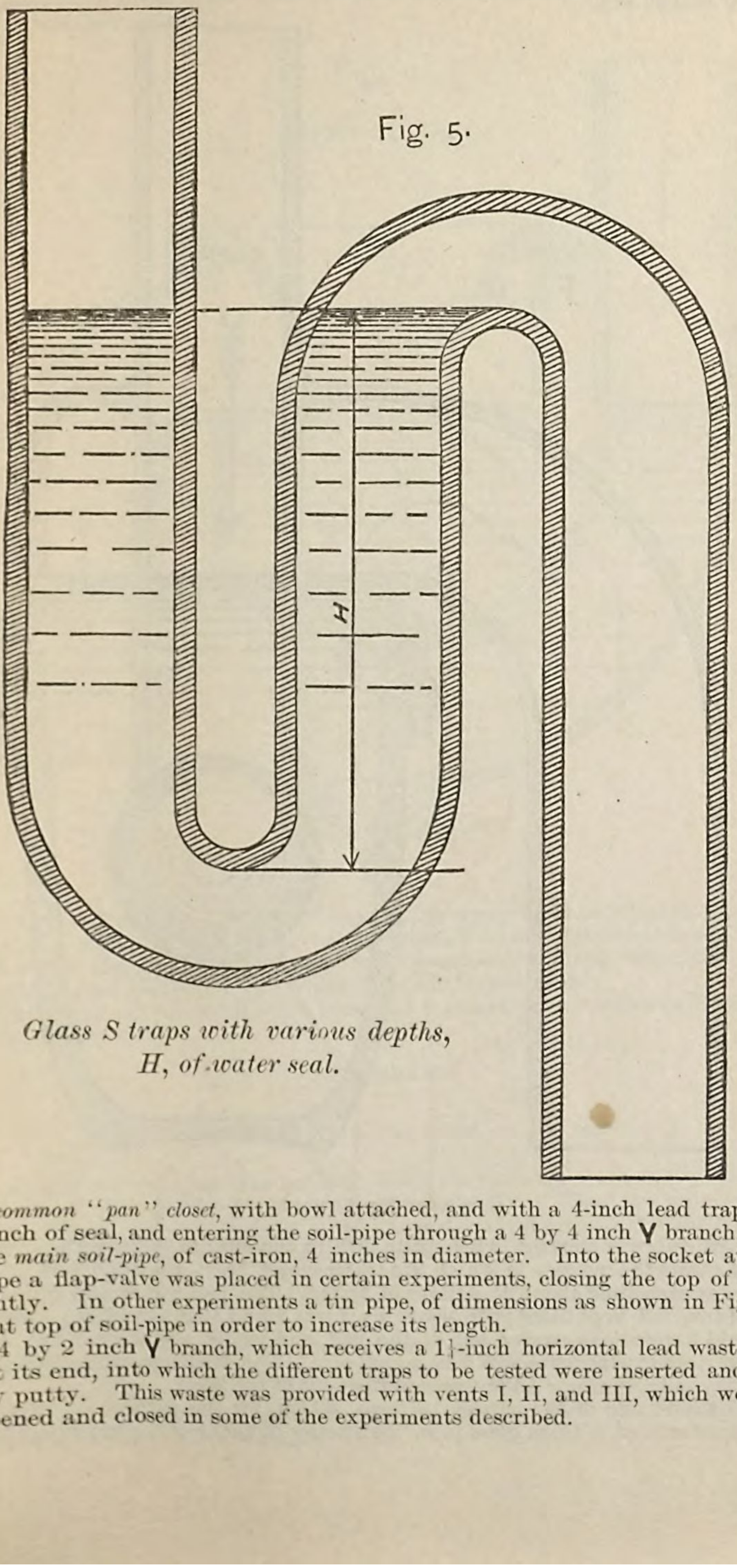
J. L. Mott's Anti-Siphoning.
4" x 2" Y Branch.

Fig. 4.



Sketch illustrating manner of discharging contents of wet bowl in some experiments.

Fig. 1 illustrates the apparatus used in the Experiments I to VII. A is a common *bath-tub*, of about 80 gallons capacity, when completely filled, with a $1\frac{1}{2}$-inch lead waste, entering the main soil-pipe through a 4 by 2 inch Y branch. The outlet of the bath-tub was closed by means of a conical-shaped 2-inch valve, operated by chain and lever. This 2-inch outlet was not obstructed, as is usual, by a strainer.



Glass S traps with various depths, H, of water seal.

B is a *common "pan" closet*, with bowl attached, and with a 4-inch lead trap, having about 1 inch of seal, and entering the soil-pipe through a 4 by 4 inch Y branch.

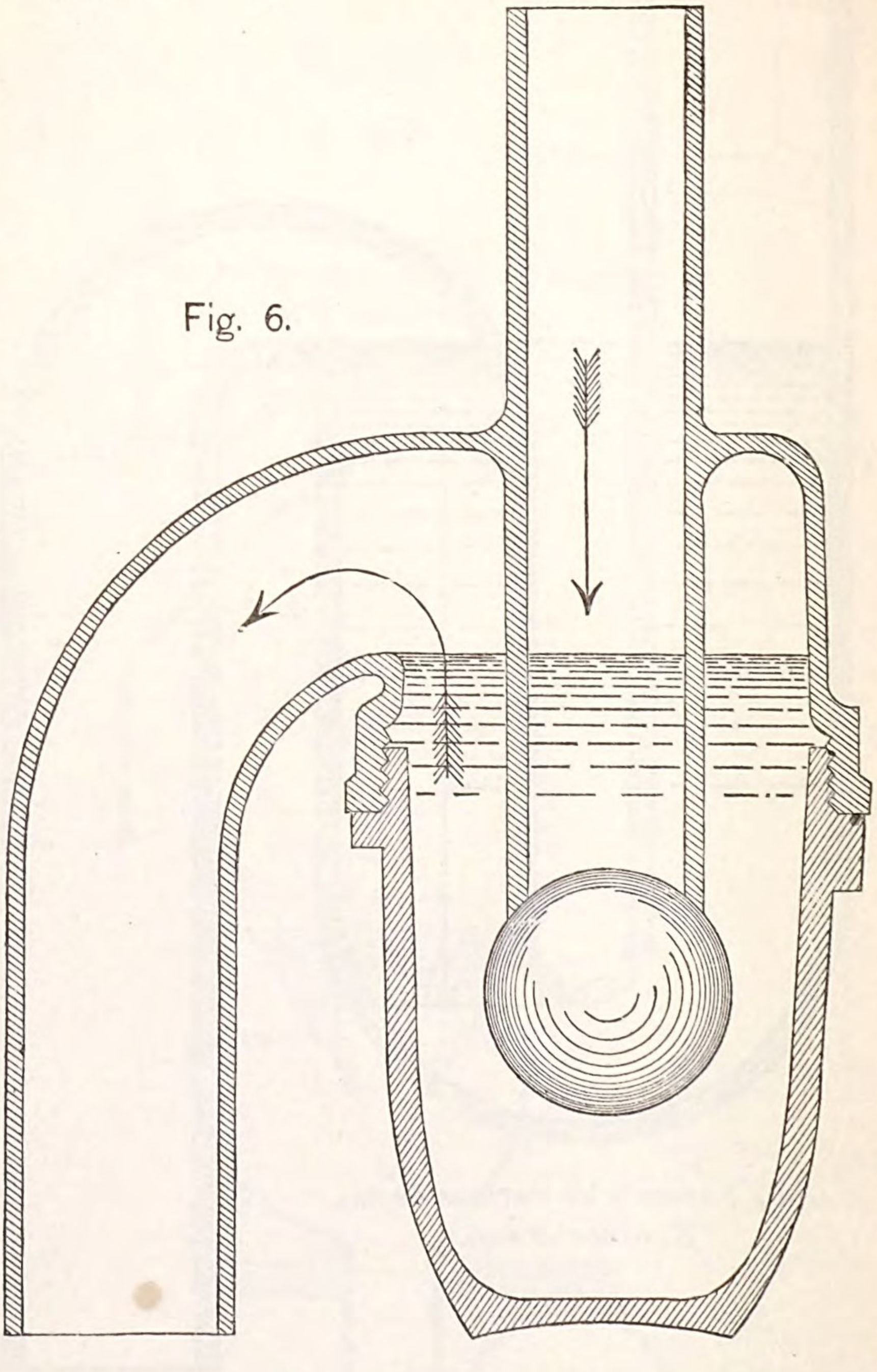
C is the *main soil-pipe*, of cast-iron, 4 inches in diameter. Into the socket at top, D, of soil-pipe a flap-valve was placed in certain experiments, closing the top of soil-pipe quite tightly. In other experiments a tin pipe, of dimensions as shown in Fig. 2, was inserted at top of soil-pipe in order to increase its length.

E is a 4 by 2 inch Y branch, which receives a 1½-inch horizontal lead waste, with a cup, F, at its end, into which the different traps to be tested were inserted and tightly joined by putty. This waste was provided with vents I, II, and III, which were alternately opened and closed in some of the experiments described.

G is a 4 by 3 inch Y branch, from which a fresh-air pipe branches, which was closed tightly during all the experiments. [This was a part of the original soil-pipe selected for the experiments, and was not purposely inserted.]

Fig. 3. shows the "Anti-siphoning Y branch," manufactured by the J. L. Mott Iron Works, New York, which was used in certain experiments in place of the common 4 by 2 inch Y branch at E.

Fig. 6.



Bower's Trap.

The bath-tub was emptied, when quite full, in one minute and twenty seconds.

Fig. 4 shows the manner in which the water-closet bowl was filled and emptied, discharging at each time about $2\frac{1}{2}$ gallons of water. The pan was drawn quite back, and a funnel inserted, kept filled with water, as it was found that a discharge from the bath-tub would draw all the water out of the pan, and would also unseal the 4-inch lead trap in certain experiments *with a closed soil-pipe*. The discharge was effected by lifting the funnel and allowing all the water to rush out of the bowl.

Fig. 5 shows one of the *common S traps*, which, for the purpose of experimenting, were manufactured of thick glass pipe, the interior diameter of the pipe being $1\frac{1}{4}$ inches,

with different depths (H) of water seal, namely, 3 inches, 3½ inches, 4½ inches, and 5 inches.

This glass pipe was somewhat contracted at the upper and lower bends, owing to inaccuracy of manufacture (as shown in Fig. 5).

Fig. 6 shows the *Bower trap*.

Fig. 7 shows *Garland's trap*.

Fig. 7.

Garland's Trap.

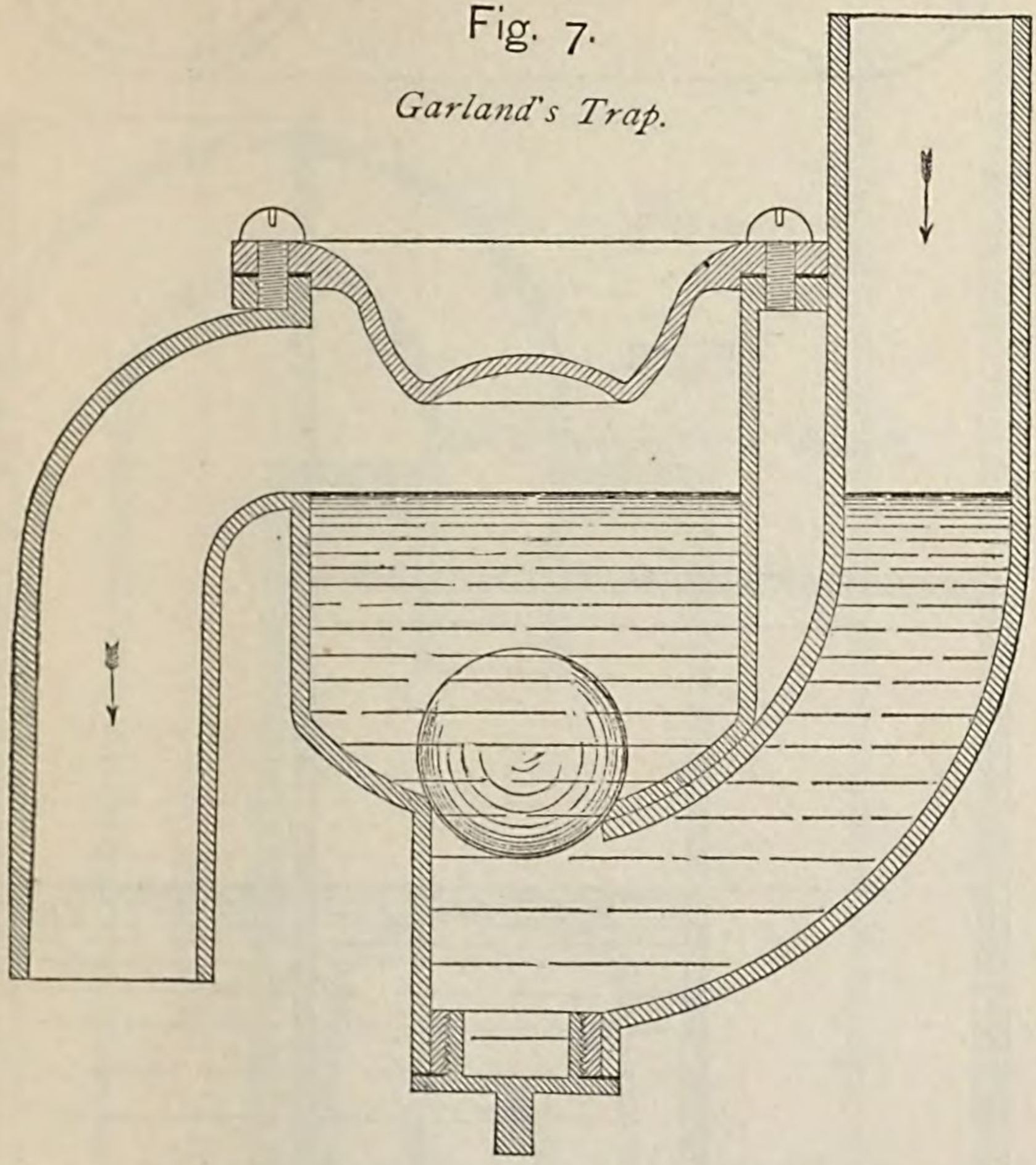


Fig. 8 shows *Brandeis's "Paragon" trap*, which seems to be in principle substantially the same as Adee's trap, without having the enlarged air and water chamber of the latter.

Fig. 9 shows the *Nicholson "Mercury Seal" trap*, which, being entirely of glass, was necessarily shaped somewhat differently from the trap as sold.

The *Cudell trap* arrived too late for trial, but it seems to be substantially the same as the Garland trap.

EXPERIMENTS.

I.—*Top of soil-pipe tightly closed, no vent open.*

The experiments were made as follows: First, the bath-tub was entirely filled, and its contents, only, discharged by opening the two-inch valve. Then the water-closet bowl was filled and the water discharged in the above-described manner. Thirdly, the bath-tub and the water-closet were both filled and emptied together.

The result in all three cases was as follows, viz: *All the traps were completely siphoned*, *i. e.*, all the water was drawn from the S traps; the water in Bower's trap was lowered about $\frac{7}{16}$ of an inch below mouth of inlet pipe, allowing the top of the India-rubber ball to drop below this inlet pipe; all the water was drawn from Garland's trap, also from Brandeis' "Paragon" trap, and from Nicholson's "Mercury Seal" trap. In the latter trap the mercury remained untouched, and the porcelain cup dropped into place, thus forming a seal. In Garland's trap the metal ball dropped back into its seat, thus forming a seal dependent on the accuracy of fit.

Fig. 8.

Brandei 's "Paragon" Trap.

II.—*Top of soil-pipe closed.*

a. Vent No. I open :
1. Bath alone emptying: S trap (3-inch water seal) loses $\frac{1}{2}$ inch of water.
2. Water-closet alone emptying: S trap (3-inch water seal) loses $\frac{5}{8}$ inch of water.
3. Bath and water-closet emptying together: S trap (3-inch water seal) loses 1 inch of water.

b. Vent No. II open :

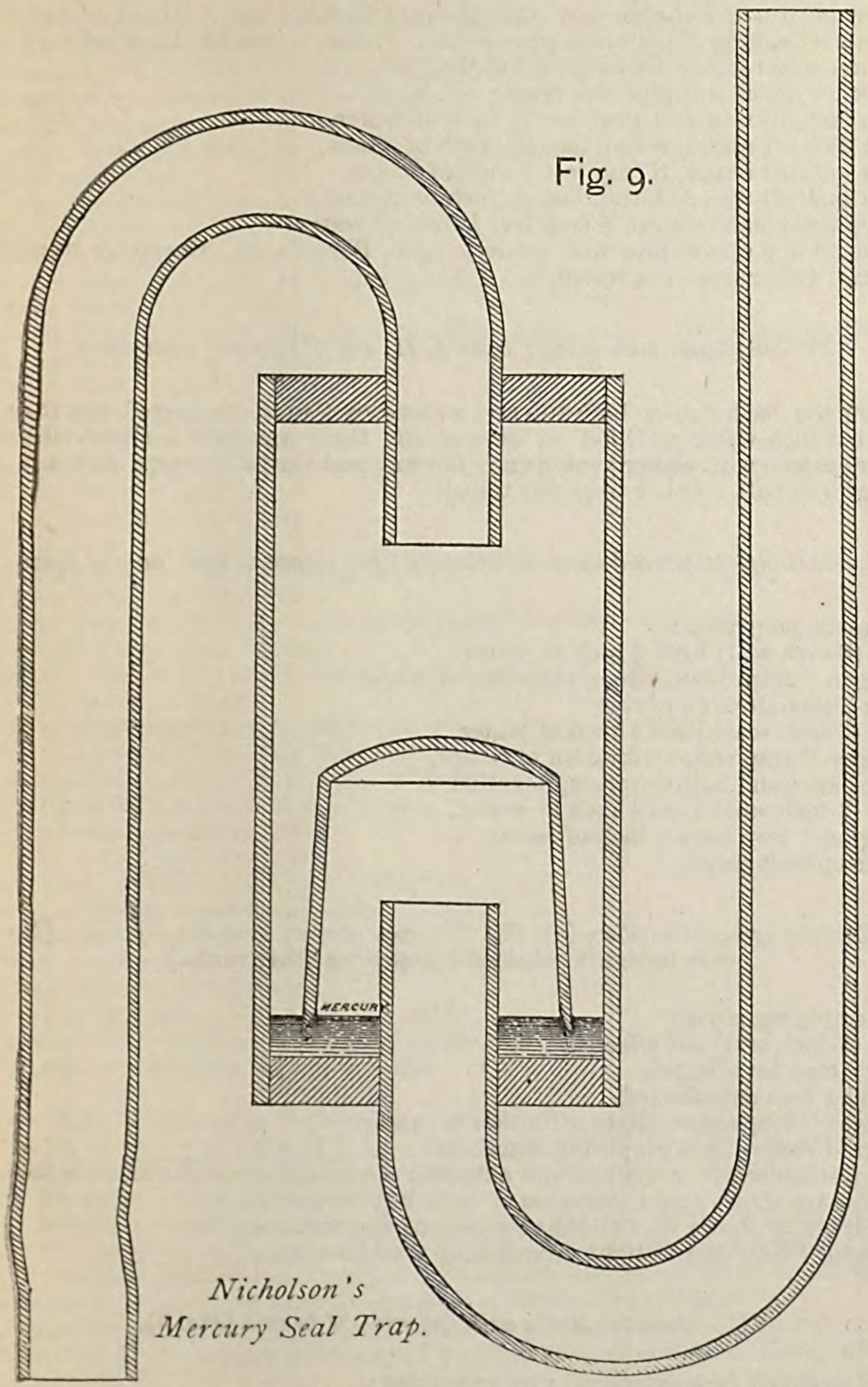


Fig. 9.

Nicholson's Mercury Seal Trap.

Tests 1, 2, and 3 give same results as above with S trap (3-inch seal).

c. Vent No. III open :
Results same as above with S trap.
The mechanical traps were not tested in these experiments.

III.—*No vents open; valve on top of soil-pipe more or less open.*

a. Bath emptying alone:
If valve on top of soil-pipe was open—
$\frac{1}{8}$ of an inch all round, S trap lost 1 inch of water.
$\frac{1}{4}$ of an inch all round, S trap lost $\frac{1}{2}$ inch of water.
$\frac{3}{8}$ of an inch all round, S trap lost $\frac{1}{4}$ inch of water.
$\frac{1}{2}$ of an inch all round, S trap lost $\frac{3}{16}$ inch of water.
If valve was entirely open, S trap lost $\frac{1}{8}$ inch of water.
If valve on top of soil-pipe was entirely open, Bower's and Garland's traps lost no water; no motion of balls was perceptible. Other mechanical traps were not tested.

b. Bath and water-closet discharging together—
If valve on top of soil-pipe was open:
$\frac{1}{8}$ of an inch all round, S trap lost $1\frac{1}{2}$ inch of water.
$\frac{1}{4}$ of an inch all round, S trap lost $1\frac{1}{16}$ inch of water.
$\frac{3}{8}$ of an inch all round, S trap lost $\frac{3}{8}$ inch of water.
$\frac{1}{2}$ of an inch all round, S trap lost $\frac{5}{16}$ inch of water.
If valve was entirely open, S trap lost $\frac{1}{8}$ inch of water.
If valve on top of soil-pipe was entirely open, Bower's and Garland's traps lost no water. Other traps not tested.

IV.—*Soil-pipe open at top; vents I, II, and III opened successively.*

If either the bath-tub or bath-tub and water-closet were discharged together, the S trap (with 3-inch water seal) *lost no water at all;* there was only a slight vibration of the water surface with either vent open. Bower's and Garland's traps show no motion of the water or ball. Other traps not tested.

V.—*Soil-pipe lengthened by an additional 54 feet; open at end; no vent open.*

a. Bath alone emptying:
S trap (3-inch seal) loses $\frac{3}{8}$ inch of water.
"Paragon" trap shows strong vibration of water.
b. Water-closet alone emptying:
S trap (3-inch seal) loses $\frac{1}{4}$ inch of water.
"Paragon" trap shows vibration of water.
c. Water-closet and bath emptying together:
S trap (3-inch seal) loses $\frac{1}{2}$ inch of water.
"Paragon" trap loses $\frac{1}{4}$ inch of water.
Other traps not tested.

VI.—*Soil-pipe lengthened as above (see Fig. 2); open at end; vent No. I open.* [No difference in result obtained by opening other vents.]

a. Bath emptying alone:
S trap (3-inch seal) not affected.
Bower's trap not affected.
Garland's trap not affected.
"Paragon" trap shows slight vibration of water.
b. Bath and water-closet emptying together:
S trap (3-inch seal); water seal not affected; slight agitation of water surface.
Bower's trap shows slight vibration of ball, but loses no water.
Garland's trap shows very slight vibration of the water surface.
"Paragon" trap shows slight vibration of water surface.

VII.—*Inserted Mott's anti-siphoning* Y *branch* (*Fig.* 3).

a. Soil-pipe closed (not extended); no vent open:
1. Bath emptying alone:
The water from all S traps was completely siphoned; Garland's trap and Brandeis' "Paragon" trap completely siphoned.
In Bower's trap water level fell $\frac{1}{2}$ inch below bottom of inlet pipe; the India-rubber ball dropped, thus unsealing mouth of inlet pipe.

b. Soil-pipe open (not extended); no vent open:
1. Bath running alone:
S trap loses $\frac{5}{16}$ inch of water.
"Paragon" trap shows vibration of water.
Bower's trap shows no motion of water.
Garland's trap, no motion of water perceptible.
2. Water-closet running alone:
S trap loses $\frac{1}{4}$ inch of water.
Other traps not tested.
3. Water-closet and bath-tub emptying together:
S trap loses $\frac{1}{2}$ inch of water.
"Paragon" trap loses $\frac{1}{8}$ inch of water.
Bower's trap shows only slight vibration of ball.
Garland's trap was not affected.

c. Soil-pipe open (not extended); one vent open (either I, II, or III):
1. Bath emptying:
S trap (3-inch seal) loses a few drops of water.
2. Water-closet running:
S trap loses a few drops of water.
3. Water-closet emptying together with bath-tub:
S trap loses $\frac{1}{16}$ inch of water.
Bower's and Garland's traps show no effect in any case. Other traps not tested.

d. Soil-pipe closed; vent III open:
1. Bath alone emptying:
S trap loses $\frac{3}{8}$ inch of water.
Bower's trap not affected.
Garland's trap not affected.
2. Water-closet emptying:
S trap loses $\frac{1}{4}$ inch of water.
Other traps not tested.
3. Water-closet and bath running together:
S trap loses $\frac{5}{8}$ inch of water.
Bower's trap shows slight movement of ball, but loses no water.
Garland's trap is not affected.

e. Soil-pipe extended by additional 54 feet; open at end; no vent open:
1. Bath alone emptying:
S trap (3-inch seal) loses $\frac{1}{2}$ inch of water.
Bower's trap shows hardly any vibration.
Garland's trap shows hardly any vibration.
"Paragon" trap lost $\frac{1}{4}$ inch of water.
2. Water-closet alone emptying:
S trap loses $\frac{3}{8}$ inch of water.
Bower's trap shows hardly any vibration.
Garland's trap shows hardly any vibration.
"Paragon" trap loses $\frac{1}{4}$ inch of water.
3. Water-closet and bath emptying together:
S trap loses $\frac{5}{8}$ inch of water.
Bower's trap loses a few drops of water.
Garland's trap loses a few drops of water.
"Paragon" trap loses $\frac{3}{4}$ inch of water.

VIII.—Fig. 10 illustrates the arrangement adopted in order to test the siphonage of traps under wash-bowls (or sinks) by a flow from another fixture, the waste of which *joins that of the* wash-bowl. The most frequent case, that of a bath-tub and a wash-*bowl on the same* line of waste, was taken.

This case was selected as it seemed likely that the ventilation of the main soil-pipe by full-size extension at the top and by foot-ventilation would not reduce the siphoning action of the flow from the bath-tub, if this flow should be sufficient to fill the section of the waste-pipe to a point past the junction of the wash-bowl waste.

The experiments demonstrated the truth of this supposition. There was no perceptible difference in the siphonage of any of the traps tested, whether the top of soil-pipe was open or closed.

With an *open, ventilated soil-pipe*, arranged as above, a flow of about 80 gallons of water from the bath-tub had the following effect on different traps:

a. S trap with 3 inches water-seal had all its water carried out, except that portion below the lower bend of trap; in other words, its seal was just broken.
b. S trap with $3\frac{1}{2}$ *inches water-seal* showed the same results.

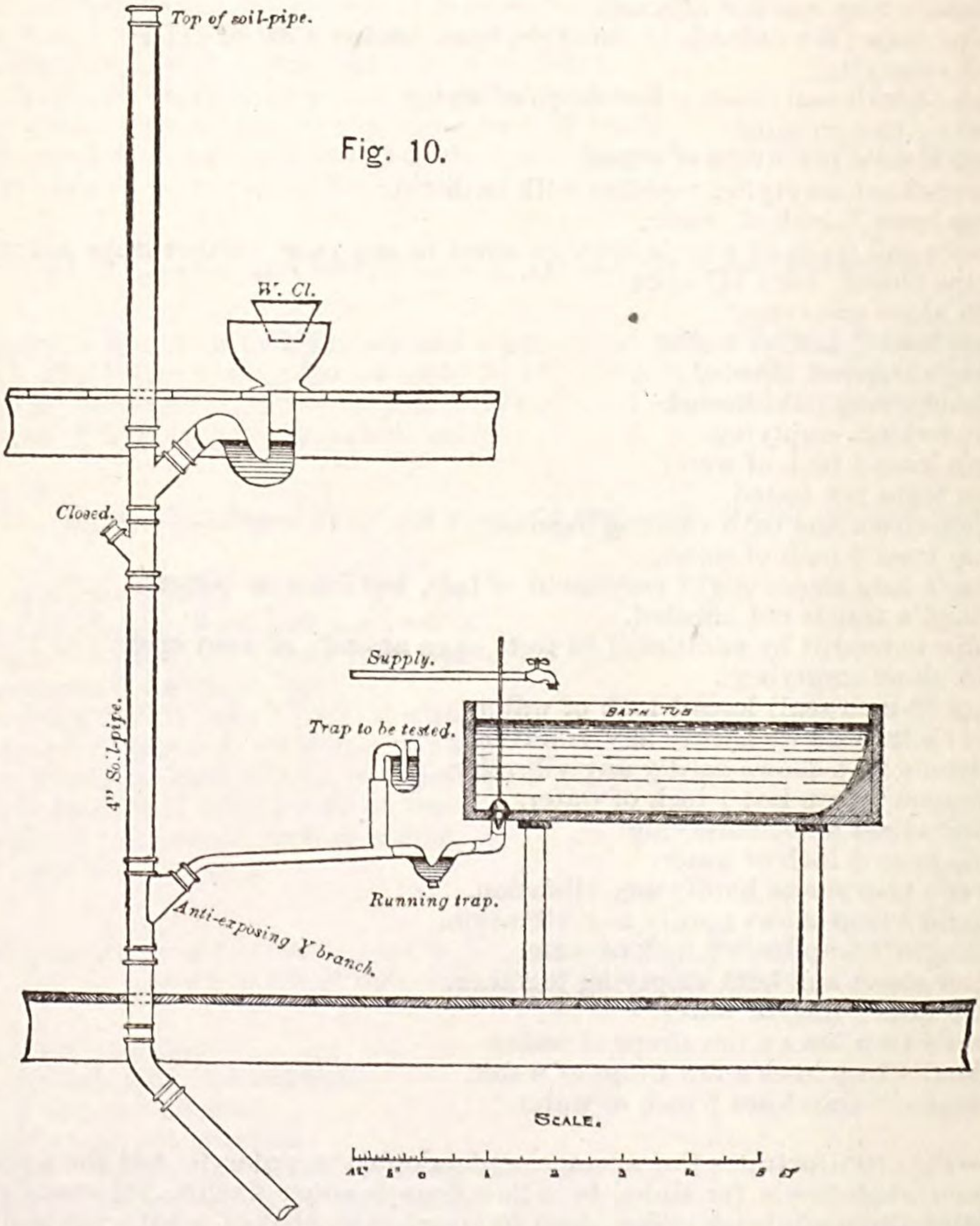
c. S trap with $4\frac{1}{2}$ *inches water-seal* had about two inches of water-seal left after emptying the bath-tub. The suction was sufficient just to hold $4\frac{1}{2}$ inches of water up. No air-bubbles were sucked through the lower bend of trap. In other words, one-half of the water was withdrawn.

d. "Paragon" trap had 2 inches of water taken out; the seal was therefore broken.

e. Bower's trap had only a few drops of water carried out by suction; the ball rotated heavily and allowed air to pass, thus breaking the vacuum, which occurred in regular intervals. There was, in addition to the ball-seal, sufficient water left to form a seal.

f. Garland's trap had $\frac{7}{8}$ inch of water taken out. The ball was agitated violently by the suction, allowing air to pass from the inlet next to bowl. There was, however, sufficient water left to form a seal in addition to the ball-seal.

Fig. 10.



g. Nicholson's trap was not tested, the earlier experiments having shown that the suction could not be great enough to break the mercury-seal, even if all water should be carried out.

All these experiments were made with the funnel-shaped outlet of the bath-tub.

This was replaced by the common outlet of a tub, with strainer and plug (about $1\frac{1}{2}$ inches diameter), and all the experiments repeated.

The results of this second set of experiments did not differ from those first obtained.

DEDUCTIONS.

The experiments described above were made under my direction, under the immediate supervision of my assistant, William Paul Gerhard, C. E., and their accuracy is beyond question.

Their results do not sustain the theory upon which are based the recommendations of

many sanitary engineers, and the requirements and suggestions on the subject of the boards of health of New York, Brooklyn, and the District of Columbia.

It is possible that that theory has been based on experiments with small glass pipes flushed by volumes of water relatively much greater than the soil-pipe of a house is ever called upon to carry. There is no doubt that if my trials had been made with a sufficient discharge of water to fill the soil-pipe nearly or quite full, the result would have been the same as that of trials with small pipes.

As we used a bath-tub containing about 80 gallons, with a 2-inch outlet unobstructed by a strainer, the tub being emptied in *one minute and twenty seconds*, and a water-closet discharging its full contents in one body at the same time, we secured a volume of flow past the branch on which the traps were tried greater than would occur in ordinary practice.

The following deductions seem to be fully justified:

1. The flow of drainage through a 4-inch vertical soil-pipe not ventilated at the top produces a very strong suction on branch pipes, the mouths of which it passes.
2. The opening of the 4-inch soil-pipe at the top practically prevents such suction even when the upper part of the pipe is 70 feet in length and circuitous in its course.
3. If each bath-tub, wash-basin, sink, &c., wastes by an independent outlet to a branch of a 4-inch soil-pipe open at the top, the siphoning of even ordinary S traps having one inch or more of seal is not to be apprehended.
4. If one vessel discharges into a branch leading from another vessel, the discharge of the latter may produce a suction on the S trap of the former sufficient nearly or quite to break its seal, unless of unusual depth.
5. Where the conditions are as described in paragraph 4, the suction is not sufficient to cause the ball of Bower's trap to drop away from its bearing, nor is it sufficient entirely to remove the water from traps which, like Garland's and Cudell's, are closed by a valve bearing vertically downward upon its seat.
6. Brandeis' "Paragon" trap showed no material superiority over the S trap. The water, under strong suction, was entirely removed from Nicholson's trap, but its mercury was not, and evidently could not be, disturbed.
7. Mott's "Anti-siphoning" Y branch of the soil-pipe possesses no material advantage over the ordinary Y branch.

The general conclusion which naturally follows these deductions would be that the separate ventilation of traps, where the main soil-pipe is 4 inches in diameter and open at the top and bottom, is unnecessary, especially as it is always simpler and much less expensive to carry each waste independently to a branch of the soil-pipe.

I venture the personal opinion that, even disregarding the question of cost, the complication of the work implied by special trap ventilation should be a controlling argument against its adoption.

SUPPLEMENTAL NOTE.

On the upper floor we fixed a Bartholomew pan-closet with a 4-inch lead trap, the same one used in the other experiments. This closet was copiously supplied with water through a valve. On the floor below entering a 2-inch Y branch, the same branch used for the other experiments, we connected the same pipe that was used for the other experiments, and attached to its further end a glass S trap having $4\frac{1}{2}$ inches depth of seal. The closet was first used in the ordinary way, but with four or five times the usual quantity of paper, newspaper in large pieces and in such quantity that they accumulated in the trap, waiting for subsequent use to move them along. In all of these trials the water in the trap showed only a slight vibration, its level, after five or six uses, not having been lowered more than $\frac{1}{8}$ of an inch. We then commenced pouring into the closet the contents of a large stable pail, probably five gallons at a time, pouring it in while the closet was discharging and as fast as the bowl of the closet would receive it. This washed the paper out of the trap, and lowered the water in the glass trap to less than $\frac{1}{4}$ of an inch below its normal level. We then took newspaper and rolled it up into balls as large as was possible to carry through the trap, and washed these through with pailfuls of water poured in as suddenly as possible. The effect on the trap was as follows: Three discharges from water-closet and pail lowered the water in the trap $\frac{1}{2}$ inch. The fourth and fifth discharges had about the same effect, and after the sixth discharge the total reduction of level in the trap was 1 inch. Subsequent discharges failed to remove any more water. The glass trap was then removed and a Bower trap was substituted and the same experiments were repeated. The closest watching of the Bower trap failed to indicate the slightest movement of the ball, and the water was not reduced below the level of the botom of the lead into which the glass cup is screwed. So far as could be judged no effect whatever was produced; certainly the action was very far from disturbing the integrity of this trap.

In all of these experiments the soil pipe was open at the top. The conditions here were much more severe than they can be in practice, and I think the experiments are now in condition to be checked by corresponding experiments made by others.

REPORT OF E. S. PHILBRICK, C. E., AND E. W. BOWDITCH, SANITARY ENGINEER.

To the National Board of Health, Washington, D. C.:

Agreeably to your request, we have made sundry experiments to test the efficacy of various styles of traps used upon house-drains under the varying circumstances and conditions to which they are subject in ordinary use, especially with the view to ascertain the liability of such traps to lose their water-seal by siphon action. For this purpose a typical stack of 4-inch and another of 2-inch waste-pipes were erected in a vertical position,* extending 57½ feet above the basement floor, with branches in the basement, and on three floors above, and having the upper ends open to the air 8¼ feet above the upper floor.

The vertical pipes extended down to a point 2 feet above the basement floor, from which they turned to a slope, falling this 2 feet in a horizontal distance of 32 feet. The 2-inch waste joined the 4-inch pipe at a branch on this slope 5½ feet from the lower end of the vertical portion. A 4-inch running trap was attached at the lower end of the slope, having a 4-inch air-hole close above it to represent the foot ventilation. At a point on the slope 6 feet below the lower end of the vertical reach a branch was inserted with a 4-inch trap in it, marked (*n*) on the plate to represent an inlet for a basement water-closet, or for any other desired fixture at that level. The relative position of these branches and floors is shown on the accompanying plate.

Traps may lose their water-seal by siphon action, *i. e.*, by lack of air pressure, either when water is poured through them or when poured through the main waste-pipe into which they discharge from fixtures at a higher level. These two processes were therefore examined separately as described below.

Since it is now generally admitted that the upper ends of all soil or waste pipes should be wide open to the air, all experiments were tried under this condition except when otherwise noted for special purposes there explained.

We will first consider the loss of the water-seal in traps caused by water flowing through them from the fixtures attached thereto.

A.—EXPERIMENTS WITH A 2-INCH WASTE-PIPE OPEN AT THE TOP.

(1.) A conical hopper was placed at the upper floor, over the 2-inch S trap at *e*, having 1⅝ inches depth of seal, and having a branch of 2 inches caliber 21 inches long, with a descent of 1 foot, before joining the Y branch on the main at D. This trap was found to lose its seal completely every time a 2-gallon pail was emptied into the hopper, unless pains were taken to pour the last part of the water slowly, by which the seal might with care be restored.

(2.) Smaller quantities of water were then poured in quickly, as is often done in practice, with the following results:

Quantities poured in—depth in bottom of pail.	Loss of water in trap.
3 inches	1⅞ inches. Seal lost.
2 inches	1¾ inches. Seal lost.
1¾ inches	2⅛ inches. Seal lost.
1½ inches	2⅛ inches. Seal lost.
1¼ inches	2 inches. Seal lost.
1 inch	1⅞ inches. Seal lost.
¾ inch	1⅝ inches. Seal lost.
½ inch	1⅞ inches. Seal lost.
¼ inch	1 inch. Seal kept.
¼ inch	1½ inches. Seal barely kept.

(3.) In order to test the effect of a strainer in retaining the water by checking the flow, two cross-bars were then inserted just above the trap water to represent a bar-strainer. Water to the amount of 1¼ inches in depth in the bottom of a pail was then poured into the hopper, but the trap still lost its seal, the water in it being lowered 1¾ inches.

(4.) To test the effect of a vent-pipe on this combination a hole was cut at the crown of the trap and one end of a lead pipe of 1-inch caliber and 28½ feet length was coupled to it. The pipe lay in a coil on the floor, with the other end wide open. Nine full pails of water were then emptied into the hopper, the loss of water from the trap on measurement being found to be as follows after each pailful, viz, 1¼ inches, ½ inch, ⅞ inch, ½ inch, ⅝ inch, 1⅝ inches, 1¾ inches, ⅛ inch, nothing. The seal was lost twice. The manner in which the water was poured influenced the result materially. Less water was lost if it hit on one side of the hopper and whirled about during its downward flow than if it was poured in directly toward the center without such spiral motion.

* We are indebted to the courtesy of the managers of the Massachusetts Charitable Mechanics' Association for the use of their fine building for these experiments.

(5.) The vent-hole was then enlarged, and a coil of pipe of $1\frac{1}{2}$ inches caliber was coupled on to it, having a length of 50 feet. Ten pailfuls were then quickly poured into the hopper in succession, finding the loss of water in the trap after each as follows, the strainer remaining at the bottom of the hopper: One inch five times, $\frac{5}{8}$ inch twice, $\frac{1}{4}$ inch once, $\frac{1}{8}$ inch twice; so that there was always at least $\frac{5}{8}$ inch of water-seal remaining. A shorter vent-pipe of same size, or a larger one of same length, would of course produce better results by lessening the friction encountered.

(6.) closing the vent-hole, an ordinary wash-bowl was then placed over the same trap, having an outlet of $1\frac{1}{4}$ inches diameter, with a bar strainer. It was filled several times and discharged witheut losing any water that could be detected from the trap. Such traps often do lose their water, however, in practice, when discharging into smaller wastes, under circumstances otherwise similar except as to the cleanness of the interior of the pipes.

B.—Experiments with a 4-inch waste or soil pipe, open at the top.

(1.) A conical hopper was placed on the third floor, on the 4-inch **S** trap at *b*, having a water-seal of $1\frac{7}{8}$ inches, with a branch 22 inches long between the trap on the **Y** branch on the main. Five pailfulls in succession were poured into the hopper, with loss of water as stated below, viz, $\frac{5}{8}$ inch, $3\frac{1}{4}$ inches, $2\frac{7}{8}$ inches, $\frac{3}{4}$ inch, $2\frac{5}{8}$ inches. The seal was thus lost three times out of the five. Smaller quantities of water were then poured in, with the following results, viz:

Quantities of water in bottom of 2-gallon pail.	Loss of depth in trap water.
Half full	2 inches. Seal lost.
$3\frac{1}{4}$ inches deep	$1\frac{5}{8}$ inches.
$3\frac{1}{8}$ inches deep	2 inches. Seal lost.
5 inches deep	$3\frac{1}{8}$ inches. Seal lost.
3 inches deep	$2\frac{1}{8}$ inches. Seal lost.

(2.) A vent-pipe $1\frac{1}{2}$ inches diameter and 1 foot long was then inserted in the upper side of the pipe, 6 inches below the crown of the trap, and ten pails discharged in succession, with the result of losing the seal completely three times and leaving but $\frac{1}{8}$ inch seal two other times, while the remaining five trials lowered the water, respectively, $\frac{3}{4}$ inch, $1\frac{1}{2}$ inches, $\frac{7}{8}$ inch, $1\frac{3}{8}$ inches, and $1\frac{1}{4}$ inches.

(3.) The size of the vent was then increased to 2 inches. Six successive pailfulls were emptied, lowering the trap water as follows, viz: 1 inch, $1\frac{1}{4}$ inches, $\frac{7}{8}$ inch, $1\frac{3}{4}$ inches, $1\frac{5}{8}$ inches, $2\frac{1}{8}$ inches, the last losing the seal.

(4.) The vent pipe was then increased to 3 inches in diameter, still 1 foot long. Ten successive pailfulls were emptied with losses of trap water as follows, viz: $1\frac{3}{8}$ inches, $1\frac{1}{2}$ inches, $1\frac{1}{2}$ inches, 1 inch, $\frac{7}{8}$ inch, $\frac{7}{8}$ inch, $1\frac{7}{8}$ inches, $1\frac{1}{2}$ inches, $1\frac{1}{8}$ inches, $1\frac{1}{4}$ inches; the seal being lost once.

(5.) This vent hole was then sealed up, restoring the original form of the pipe as far as possible, and another vent pipe of $1\frac{1}{2}$ inches diameter and 1 foot length was inserted on the highest part or crown of the trap. Nine successive pails were emptied with loss of water in the trap as follows, viz: $1\frac{1}{2}$ inches, $2\frac{3}{8}$ inches, 2 inches, 1 inch, $2\frac{1}{4}$ inches, $\frac{3}{4}$ inch, $\frac{1}{2}$ inch, $1\frac{1}{4}$ inches, $1\frac{1}{4}$ inches. The seal was thus lost three times out of nine.

(6.) The vent pipe, still one foot long, was then enlarged to 2 inches, with an elbow 2 inches long at its upper end. Ten pailfulls in succession were emptied with the following losses in the trap, viz: $1\frac{1}{16}$ inches, $1\frac{5}{8}$ inches, $1\frac{1}{4}$ inches, $2\frac{1}{4}$ inches, $1\frac{1}{4}$ inches, $1\frac{5}{8}$ inches, $\frac{1}{2}$ inch, $1\frac{1}{2}$ inches, $\frac{1}{4}$ inch, $2\frac{1}{4}$ inches. The seal was here twice lost, and came very near it twice more.

(7.) The vent pipe, 1 foot long, was then increased to 3 inches diameter. Ten pails were emptied with loss of water as follows, viz: $\frac{1}{2}$ inch, $\frac{5}{8}$ inch, $\frac{7}{8}$ inch, $\frac{3}{4}$ inch, $1\frac{1}{2}$ inches, 1 inch, $\frac{3}{4}$ inch, $\frac{1}{4}$ inch, $\frac{3}{4}$ inch, $1\frac{1}{2}$ inches. The seal was not lost now, though coming within $\frac{3}{8}$ inch of it.

In all these three last experiments, where the vent was in the crown of the trap, the water was seen to dash up into the vent pipe and spill over the top of it, even when a foot long and 3 inches in diameter. When it receded a portion of this water dropped back into the trap and just sufficed to keep its seal when the vent was 3 inches in diameter, but not when smaller. The loss of water was plainly attributable to the *momentum* of the stream when passing through the trap quite as much as to the air draft. This was proved by varying the direction in which the water was poured into the hopper. The above records are all the results of pouring it in at the side of the hopper *opposite the trap*, so that the velocity of the water acquired in its fall from the pail

through the hopper was not impaired by such an abrupt change of direction when striking the bottom of the trap, as it would be if the pail were applied either directly over the trap or half way between this and the former position. Moreover, there was no strainer at the base of the hopper to break the momentum, the hopper being of the form formerly much used for water-closets.

(8.) In order to eliminate, in some degree, the effect of this momentum, the same experiments were tried with another form of hopper, suitable for a water-closet, and having its trap *above* the floor, such as is marked "Water-closet No. 1" on the plate. The distance through which the water had to fall from the edge of the hopper to the bottom of the trap was thus reduced by 10 inches. The trap had a seal of 2 inches and was first tried with no vent in it. It discharged directly into a patent **Y** branch with expansion at top, devised for the purpose of preventing siphoning. Nine pailfulls were emptied with a lowering of the trap water as follows, viz: 1 inch, $\frac{1}{2}$ inch, $1\frac{5}{8}$ inches, 2 inches, $\frac{1}{4}$ inch, nothing, $2\frac{1}{8}$ inches, $1\frac{7}{8}$ inches, $2\frac{1}{4}$ inches, losing the seal three times in the nine. Another trial under similar conditions showed a loss of the seal three times in five.

(9.) A vent pipe 1 foot long and $1\frac{1}{2}$ inches in diameter was then applied at the crown of the trap. Ten pailfulls were emptied to favor a loss of water by momentum, but no appreciable loss of water occurred.

In order to eliminate from the last two experiments the possible effect of the offset in the main pipe directly under the connection of this branch, the same experiment was tried on the floor below, at "Water-closet No. 2," with essentially similar results, indicating that the offset did not modify the case perceptibly.

(10.) The effect of excessive lengths of vent pipes was experimented on with the result that under conditions which indicated perfect security with a pipe 1 foot long and $1\frac{1}{2}$ inches diameter, on a 4-inch trap, a coil of pipe 50 feet long coupled to the vent rendered it inefficient once in eight trials, the trap having 2 inches seal, being siphoned in this case, and lost 1 inch of water three other times out of the eight.

In another case where a shut vent of 1 inch in diameter seemed to be quite efficient, a coil of 1 inch pipe with a length of $28\frac{1}{2}$ feet being coupled to it rendered the vent of apparently little use, for the trap lost its seal at every trial.

(11.) In order to test the effect of a partial closing of the top of the soil pipe, a piece of pasteboard was laid over it having a hole of only 2 inches diameter. Such a stricture is often produced above the roofs of buildings in cold climates by the formation of ice through condensation of the vapor of water which rises with the air through the soil pipes. It was found that it was much more difficult to retain water in the traps in all cases under this condition except where special vents were applied to the traps themselves. In such cases, the stricture above described at the top of the soil-pipe seemed to produce no appreciable effect.

We will next consider the loss of water in traps by the flow past them from above through the main into which they may discharge.

C.—Experiments with a 2-inch waste-pipe, open at the top.

(1.) A trap of $1\frac{1}{2}$ inches caliber of S form, having $4\frac{1}{4}$ inches depth of seal, and having strips of glass inserted in its sides where the lead was removed, was applied at the branch marked G on the plate. The plug connecting with the 2-inch waste was then drawn from the bath-tub on the floor above, and the water allowed to run a few seconds. The water in the trap was found to have fallen $4\frac{1}{8}$ inches. The next trial destroyed the water seal with a flow of ten seconds. A third trial produced the same result in four seconds. Five pailfulls of water were then poured in succession into the hopper at *e* on the third floor with this result: The seal was twice entirely lost, and for three times the water was lowered $4\frac{1}{8}$ inches, leaving only $\frac{1}{8}$-inch seal.

(2.) This deep trap was then removed, and an S trap of same caliber applied in its place, having only $1\frac{1}{2}$ inches seal, with glass strips in its sides and a vent hole 1 inch in diameter on its crown. Five pailfulls in succession were poured into the hopper above with no perceptible loss of water in this trap. Its water was agitated less than $\frac{1}{8}$ inch.

(3.) The vent hole was then half covered and the experiment repeated, with scarce a perceptible loss of water.

(4.) The vent hole being wide open, the bath-plug was drawn for twenty seconds. The water in the trap oscillated about $\frac{1}{8}$ inch, but was not lowered perceptibly.

(5.) This trap was removed and a Cudell trap substituted, such as is shown at **S** on the plate, with no air vent in it. The bath plug above was raised for ten seconds, and the trap was found to have lost all its water. The plug was raised again twice for six seconds each time, and the trap twice again completely lost its water seal. Three pailfulls of water were emptied at the hopper in succession, and the trap lost its water seal each time.

(6.) This trap was removed and a Bower trap substituted, without special air vent, such as is shown at T on the plate. The plug was drawn from the bath above for fifteen seconds, and the trap was found to have lost $1\frac{1}{2}$ inches of water, leaving about $\frac{3}{16}$-inch

water-seal. A second and third trial of the same flow, without refilling trap, left less than $\frac{1}{16}$-inch seal. Air was now readily sucked up through the trap by the mouth, in spite of its ball, which was new and clean. On filling the trap again and pouring a pailfull into the hopper above, $\frac{3}{8}$-inch seal was left. Two pails more, without first refilling trap, left about $\frac{1}{4}$-inch seal. The hopper was then filled by a pailfull of water and discharged by lifting a plunger, and $\frac{1}{2}$-inch seal was left.

(7.) This trap was replaced by an Adee trap, such as is shown at Q on the plate, having $1\frac{1}{8}$ inches seal. The flow from the bath above destroyed the seal in ten seconds for three trials in succession. Three successive pailfulls of water emptied at the hopper above left from $\frac{1}{16}$-inch to $\frac{1}{8}$-inch seal after each.

D.—EXPERIMENTS WITH THE 4-INCH WASTE OR SOIL PIPE OPEN AT THE TOP.

(1.) The 4-inch trap at *g* on the plate having 2 inches depth of seal was observed. The vent-hole in the trap was at first closed.

The discharge of a pailfull of water at the hopper above lowered the trap water $\frac{7}{16}$ inch.

The simultaneous discharge of the hopper and water-closet above lowered the trap water $2\frac{3}{16}$ inches, destroying the seal.

The discharge of the hopper while the bath waste was flowing lowered the trap water $2\frac{1}{16}$ inches and broke the seal.

The discharge of the water-closet above six times in succession lowered the trap water, respectively, $\frac{11}{16}$ inch, $1\frac{1}{8}$ inches, $\frac{1}{2}$ inch, $1\frac{1}{4}$ inches, $\frac{7}{8}$ inch, and $1\frac{1}{2}$ inches.

The discharge of the water-closet hopper and bath together, six times in succession, lowered the trap water from $2\frac{5}{16}$ inches to $2\frac{1}{2}$ inches, destroying the seal every time.

(2.) The vent-hole, $1\frac{1}{2}$ inches in diameter in this trap, was then opened. The water-closet hopper and bath were then discharged simultaneously, ten times in succession, with loss of only $\frac{1}{8}$ inch of water from the trap in any instance.

(3.) This same experiment was twice repeated with the top of the soil-pipe closed, showing a loss of only $\frac{3}{8}$ inch of water from the trap in any case.

(4.) The water in the large trap at *j* (on the plate) was observed with discharges of water from above similar to those noted in the last three experiments, and with results so essentially similar that they are hardly worth reciting in detail.

(5.) An S trap of $1\frac{1}{2}$ inches caliber and $1\frac{1}{2}$ inches depth of seal was attached to the branch marked J on the plate, on the second floor. With no vent in the trap, water was discharged ten times in succession from the bath and water-closet above for periods of five to eight seconds each. The trap was unsealed four times and lost from $\frac{5}{8}$ inch to $1\frac{1}{8}$ inches of water at the other six trials.

(6.) The same experiment was repeated with an opening in the crown of the trap $1\frac{1}{8}$ inches diameter, with loss of water in the trap as follows: $\frac{1}{4}$ inch, few drops; $\frac{1}{8}$ inch, $\frac{3}{16}$ inch twice, few drops twice; $\frac{1}{16}$ inch twice, few drops.

(7.) A Bower trap was attached at the same place, with no air vent in it. The water-closet above was discharged while the bath waste was running ten times successively. The trap lost its water-seal four times, and lost at the other six trials from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inches of water.

(8.) A Cudell trap was then substituted, at the same branch, marked J. The water-closet was discharged above, while the bath waste was flowing ten times in succession. Nine times the water was all taken out of the trap, and once there was about $\frac{1}{8}$ inch left.

(9.) A round trap, having $2\frac{1}{2}$ inches seal, as shown at R, was then substituted at this branch J. The discharge of water-closet No. 1 lowered its water $\frac{1}{8}$ inch. The discharge of same closet and the hopper together lowered it $\frac{3}{4}$ inch. Further trials of this trap showed that the discharge of the largest volumes of water possible at once from the three fixtures above could not unseal it, for though quantities of air were drawn through it, as seen through the glass in its sides, there was so much space for the air to pass by the water that the seal always remained efficient. It would be instructive to try such a trap after it had been encumbered with grease and other rubbish, as is often the case, and where this space for air to pass by the water might perhaps not be found.

Before deducing any rules for practice from these experiments it must be remembered that they were made with new, clean, enameled pipes, while those in ordinary use are always more or less encumbered with scales and tubercles of rust and with the grease and slimy coating deposited by the sewage. Even in vertical pipes such collections often reduce the diameter $\frac{1}{4}$ of an inch, thereby reducing the sectional area of a 4-inch pipe about $12\frac{1}{2}$ per cent., and of a 2-inch pipe about 23 per cent., while in sloping waste-pipes, like those under waste-traps and bath-tubs, the accumulation of solid matter from the sewage often amounts to a permanent occupation of one-half or three-fourths of the whole section.

It needs but a casual reference to the above experiments to prove, what is generally known and admitted already, that the difficulty of retaining water in traps increases as the size of the waste-pipe decreases, so that we must expect, with pipes that have been

used for any considerable period, much more tendency in the traps to lose their seal by unequal air pressure than in the cases recorded above under conditions which are otherwise similar. Two causes combine to produce this result, viz: The smaller pipe is filled by a less volume of water, which acts like a piston as it passes downward, while the air that follows from the vents above finds in the smaller pipes less room to flow in, and a consequent increase of friction, which, by impairing its velocity, leaves the unequal pressure that we complain of.

Moreover, there are various conditions affecting the stability of water in traps which may not have been foreseen and covered in these experiments. The various results actually arising when repeating the same experiment under conditions apparently identical show how unsafe it is to make general deductions from a small number of trials. These variations may be accounted for in part by the various paths taken by the water when poured at different times from one vessel to another, and when running down a vertical pipe. There is always a tendency to follow a spiral course. When such a twist is given to the water at the start, in the hopper, it generally checks the velocity so as to prevent the unsealing of the trap attached to it. When occurring in the vertical pipe, as it passes by the connections of other branches, it makes a great difference whether the path of the spiral happens to hit exactly across the opening of such a branch or happens to pass on the other side of the main.

It would require much more time and labor than we have spent upon the subject to exhaust any considerable part of such possible variations which are likely to occur in daily practice. The relative size and position of the different branches, the quantities of water passing through them, and the endless number of combinations of flow from different fixtures which occur daily in any large house or hotel, all tend to vary the result to a degree which should induce a prudent man to allow a large margin on the side of safety. The risks are known to be considerable in case of exposure of untrapped drains in dwellings. It should also be remembered in this connection that we live in a climate where artificial heating of houses, warm chimneys, and the careful closing of wall and window cracks combine to produce a decided pressure of air from without the house inward, acting through all our house drains through several successive months every year, and that we know of no method as yet so satisfactory for resisting this pressure as the use of the water-sealed trap. We are aware that a large number of ingenious devices have been introduced to supplement the water-seal by mechanical valves with moving cups, balls, and flaps, but we have never seen one of these devices which could be relied upon to shut out air after the apparatus had been used and defiled for a few months by a flow of ordinary house drainage, whether from laundry, kitchen, or lavatory.

CONCLUSIONS AND RECOMMENDATIONS.

E. When hopper water-closets are used for the emptying of slops, and when the trap is placed below the floor, it is difficult to preserve the seal in the ordinary form of S trap, even by a vent-pipe attached thereto, unless this be applied directly at the crown of the trap and be as large as 4 inches in diameter for at least a foot above the trap. The momentum of the falling water helps the air-draft to do the mischief. An abrupt change of direction may impair this momentum. But since it is manifestly useless to control the direction in which the water is emptied into the hopper, we should endeavor to check it by the form of the apparatus. We must assume that the water will generally be emptied in the most convenient manner, and this is quite as likely to favor the loss of the trap-water by momentum as otherwise, unless the form of the fixture controls it. An increase of the depth of the seal and a decided, quick upward turn at the bottom of the trap will both operate in this direction. But there are limits to the advisable depth of water-seal, arising from the tendency of deep traps to retain their filth. Moreover, all angles, and very abrupt changes approaching the form of an angle, should be avoided for the same reason. The proper medium is only to be attained by the use of good judgment in any case.

F. Where a short hopper is used for emptying slops, with a trap above the floor, though the momentum of the falling water is considerably reduced by the diminished distance through which the water falls from the pail to the trap, there is still no security for keeping the water in such a trap, unless supplied by a special air-vent. This should be at least $1\frac{1}{2}$ inches in diameter, if more than a few feet in length, and even larger if passing to other floors above.

G. Other forms of traps which, like the one referred to in Experiment D (9), might save and retain their water by means of a lateral expansson of their basins, are objectionable, owing to the amount of filth which they retain subject to decomposition. The ordinary S trap alone, with ample air-vent, is, therefore, recommended for use under water-closets, and also for all other fixtures where its proper ventilation can be secured within reasonable limits of expense. The proper size and length of such vent-pipes must be largely a matter of judgment, and will be referred to again. Their combinations admit of such a great diversity of conditions that we can only urge that every case should

be severely tested by repeated trials, applying larger vents, or making the small sizes shorter, whenever any doubt arises as to their efficiency.

H. The above precautions are of more importance and should be observed with greater care when waste pipes are used of smaller size than 4 inches to carry the flow for more than one or two feet in distance. The difficulties arising in such cases are illustrated by the experiments A and C above noted.

I. Whenever branch inlets are connected to a line of waste or soil pipe that is vertical or approaching that direction above which branches other fixtures are used for discharging water into the same main, there is great risk of losing the water from the traps attached to such branches whenever the upper fixtures are used. No form of trap without special air-vent has come to our notice which is not likely to lose its water-seal under such circumstances, even when the top of the soil or waste pipe is open, except those which like the round trap above referred to are objectionable for retaining filth. This form of trap, shown at R on the plate, is largely used about Boston for the reason that its seal is difficult to be broken. The objection above alluded to is intended to be met by providing a large capped opening at the top for the removal of the filth. In practice this is seldom done, and if done without the help of a mechanic the cover would rarely be closed tightly, as now constructed, so that the frequent cleaning of such traps is very difficult to accomplish and an annoyance when done. The risk involved by the use of such small cesspools in the house would be small if perfect tightness could always be insured at the joint of the cover. Air-vents are sometimes applied to them, but are of doubtful utility. Experts differ in opinion, according to their individual experience, as to their liability to become choked with filth in their upper part. The writer has seen them so far encumbered with grease, &c., as to lose most of their advantages in ability to retain their water-seal. We can therefore recommend with less reservation the use of a well-ventilated S trap wherever the vent-pipe can be applied without unreasonable cost. The round trap may often be properly used, however, in old houses, in places where the introduction of a vent might be very inconvenient or costly.

J. The best and most simple remedy for the siphoning of traps in most cases is undoubtedly to be found in the introduction of air at the normal pressure at the crown of the trap. The reason for preferring the crown to any other place can be found in the above record. (See Experiments) B (2), (3), (4), (5), (6), (7).) No definite rules can be given for the size or length of vent-pipes. (See paragraph C, above.) Yet it may be said that it is not safe to trust to a vent-pipe of less size than that of the trap it is to serve until they get above 2 inches diameter, except they be of only a few feet in length, before they join those of a larger size. The greater efficacy of a vent applied directly at the trap, as compared with the air supply through the top of the main soil-pipe, is shown by experiments B (11) and D (2) and (3).

K. There is still another risk arising from change of air pressure in drains besides that of siphoning traps. The latter is the result of lack of pressure, while an excess of pressure is also to be avoided. The following experiment may illustrate this point. It is applicable to all house drains having an exterior main trap or discharging into a cesspool at a point below the water-line by a dipping inlet pipe, as is often done for the sake of checking the back flow of gas from the cesspool.

(1.) The trap at the lower end of the system, at the point marked V on the plate, was filled with water, and the air inlet just above it was capped. The trap at (*n*), on the basement floor, was then filled with water, and a pailfull emptied at the hopper on the third floor, connecting to the 4-inch main. The air was so compressed ahead of the falling water that it was forcibly blown out at the trap (*n*), carrying with it a good deal of water, showing how foul air from a drain can thus be ejected into the apartments of a house in considerable volumes. The fixture connected with such a trap may generally be able to collect and restore to the trap enough of the water expelled to save its seal, and thus no apparent defect would be found unless the blowing out of the foul air through the trap happened to attract attention.

(2.) On removing the cup from the air-hole near V, and repeating the experiment, no apparent disturbance followed in the trap (*n*).

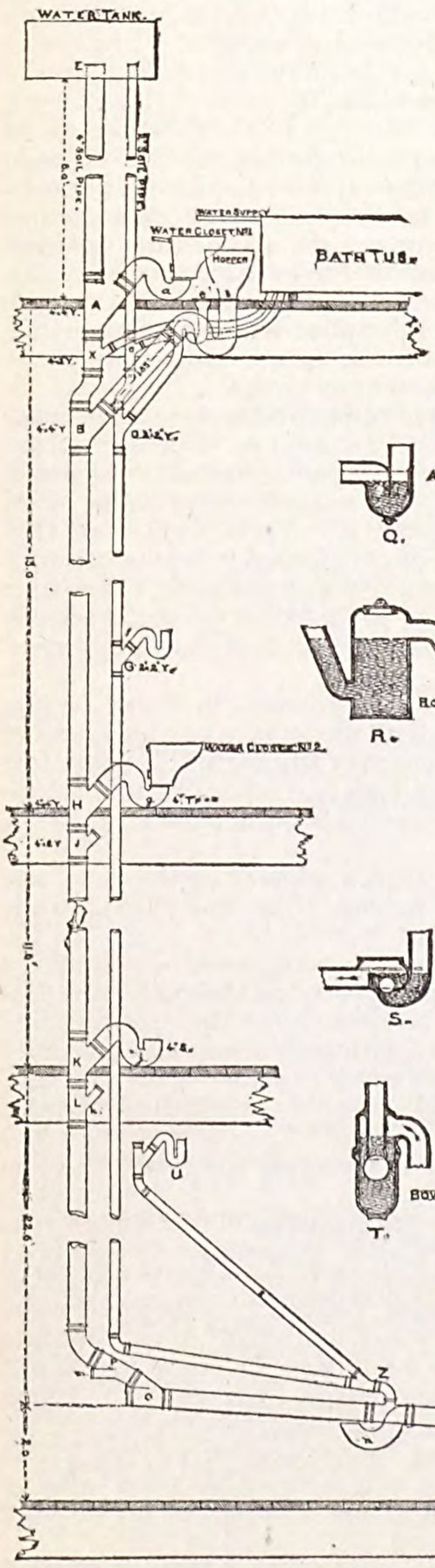
(3.) Another experiment was tried to illustrate the retarding effect of friction and consequent change of pressure in small waste-pipes, as follows: An ordinary S trap of $1\frac{1}{2}$ inches seal and $1\frac{1}{2}$ inches caliber was attached in the basement to the branch marked U of the 2-inch waste-pipe. This represents a combination frequently occurring in the waste-pipes of pantry sinks. This trap was filled with water, and a pailfull emptied into the 2-inch waste on the third floor above. The air was forcibly blown out of the trap at U by the compression of the air ahead of the descending charge, even when the 4-inch air-hole near V was open in the main below. This result was plainly due to the friction caused by the air rushing through the abrupt bend at the connection marked Z. It shows the risk incurred by branching small waste-pipes into one another when used on several floors, and the impropriety of using a quarter bend and T branch at Z instead of a Y branch.

Though condemned by most English authorities, it is doubtless a safer way to connect

the waste-pipes of baths, bowls, &c., used on upper floors directly to the large soil-pipe by Y branches as near as practicable to the fixtures drained, than to erect long lines of smaller-sized wastes separately for such purposes. Certainly the larger the pipe, the less is the risk of any abnormal air pressure occurring by its use, so long as the wastes are not likely to become encumbered seriously by accretion of solid matter. The provision of separate wastes for baths, &c., all the way to the basement is considered important in England, probably because of a dislike to make inlets in the soil-pipe used for water-closets. But the risks arising from the use of a small-sized waste through such distances are thus proved to be considerable and should not be ignored, while those arising from the common use of a 4 or 5 inch pipe for water-closet and general refuse water on several floors may have been overrated in England.

EDWD. S. PHILBRICK.
ERNEST W. BOWDITCH.

BOSTON, *June* 10, 1882.



APPENDIX C.

REPORT OF AN INSPECTION OF CERTAIN HEALTH RESORTS.

BY E. W. BOWDITCH, SANITARY ENGINEER.

REPORT ON SANITARY CONDITION OF NEWPORT, R. I.

Newport has always been considered, and unquestionably is, naturally, an exceptionally healthy place, comprising, as it does, the southern end of the island of Rhode Island, which juts far out into the waters of Narragansett Bay and the open Atlantic.

For many years it has been the fashionable resort for thousands of summer visitors, as well as some hundreds of winter guests, and the town being situated to a large extent on the summit and southwestern slope of the backbone of the island, permits a free circulation of air from almost every direction, particularly in summer, when the prevailing wind is from the southwest.

The soil is a stiff retentive clay, for the most part quite moist, spongy or marshy, the underlying ledge occasionally appearing above ground, and frequently found within from ten to twenty feet of the surface.

In a number of instances it is known that the ledge, which is at times found in horizontal layers and somewhat porous, has been the means of conveying appreciable quantities of sewage and foul matter very considerable distances, to water supplies—in one case nearly 100 feet.

Of the ponds within city limits, known severally as Easton's, Almy's, and Lily, the first, which has quite a respectable water-shed, of questionable purity, is used for the city water supply, while the others, so far as known to the writer, are used for cutting ice only. Easton's pond, one of those fresh-water basins frequently met with on the Atlantic shore, standing about on the same level as tide-water and separated from it only by a sand beach perhaps 400 feet wide (a barrier that may have been erected by the sea itself), has been divided in two parts by an artificial dam, constructed at the time the water works were first built, so that the upper pond is the only one directly drawn upon. Steam pumps force water from this upper pond to a reservoir, located on the highest hill in the vicinity, just over the city limits, in Middletown, from which point it is distributed by mains and service pipes to customers throughout the city. (It is to be borne in mind that the water works are owned by private parties, and that whatever the shortcomings of the supply may be, the city is little, if any, to blame in the premises.)

Newport is a peculiar place. The old city, situated on the western slope of the island, and running to the water's edge, contains few more dwellings than it did in the beginning of this century, except where portions of the harbor have been filled in for business purposes. Many of the old buildings still remain the same delightfully picturesque old houses they originally were, little altered save by the action of the elements, with the same old cisterns, cesspools, and wells, many of them becoming fouler and fouler year by year from the time they were first built up to the present moment. Growing out from this, on three sides, but largely toward the south, southeast, and southwest, is the new city of summer residences, where one can see at a glance evidences of the skillful architect and engineer, and where sanitary arrangements are, in some cases, the best that human knowledge has yet devised.

In spite of this, it would puzzle a person to find more than a very limited number of estates where even moderately satisfactory sanitary arrangements are in use.

Without going too deeply into particulars that would prove of little general interest, it is sufficient to say that the sanitary welfare of the city is supposed to be looked after by the mayor and board of aldermen, "with the city physician occasionally," "and sometimes the city solicitor." This board appoints a health officer, who carries out the directions given him by the chairman. In city hall is what is termed the nuisance-book, in which any one may enter complaints, which will, in due course of time, come before the full board.

Granted that these men have the good health of the city as much at heart as any body of men possibly could, that many of them being fathers of large families are therefore doubly interested in the matter, that on the proper sanitary condition of the city may depend their bread and butter, it is a question of grave doubt whether it is possible for a board so constituted, whose official life is liable to terminate at any election, even with the best intentions to attend properly to the health of the city.

Certain places were pointed out by the Sanitary Protection Association as desirable to visit, statement being made that the attention of the local board had been called repeatedly to the premises in question, but no action had been taken of any description. Fearing to obtain a false impression of the general condition of the city by so doing, the places mentioned were carefully avoided, till later on, when the liberality of private citizens enabled the examination to be largely extended.

To obtain some idea of the city, primarily, three hotels were examined, four school-houses, and some twelve dwellings. In addition to this the health records, so called (the nuisance-book), was, through the courtesy of the mayor, placed at the disposal of the examiner.

Of the three hotels, one (the Ocean House) shows the best maintenance of any summer hotel visited at any place. Many of the arrangements are old fashioned and unnecessarily complex, but the entire establishment, water-closets, baths, kitchens, pantries, laundries, garbage sheds, &c., were found sweet and clean (examination was made one-half hour after breakfast, giving less than 15 minutes' notice of inspection). The arrangement of water-closets was considered so desirable that a similar form will quite likely be adopted in other seaside public houses. Of the other two hotels, one was far neater than is usual, but the third was unequivocally bad.

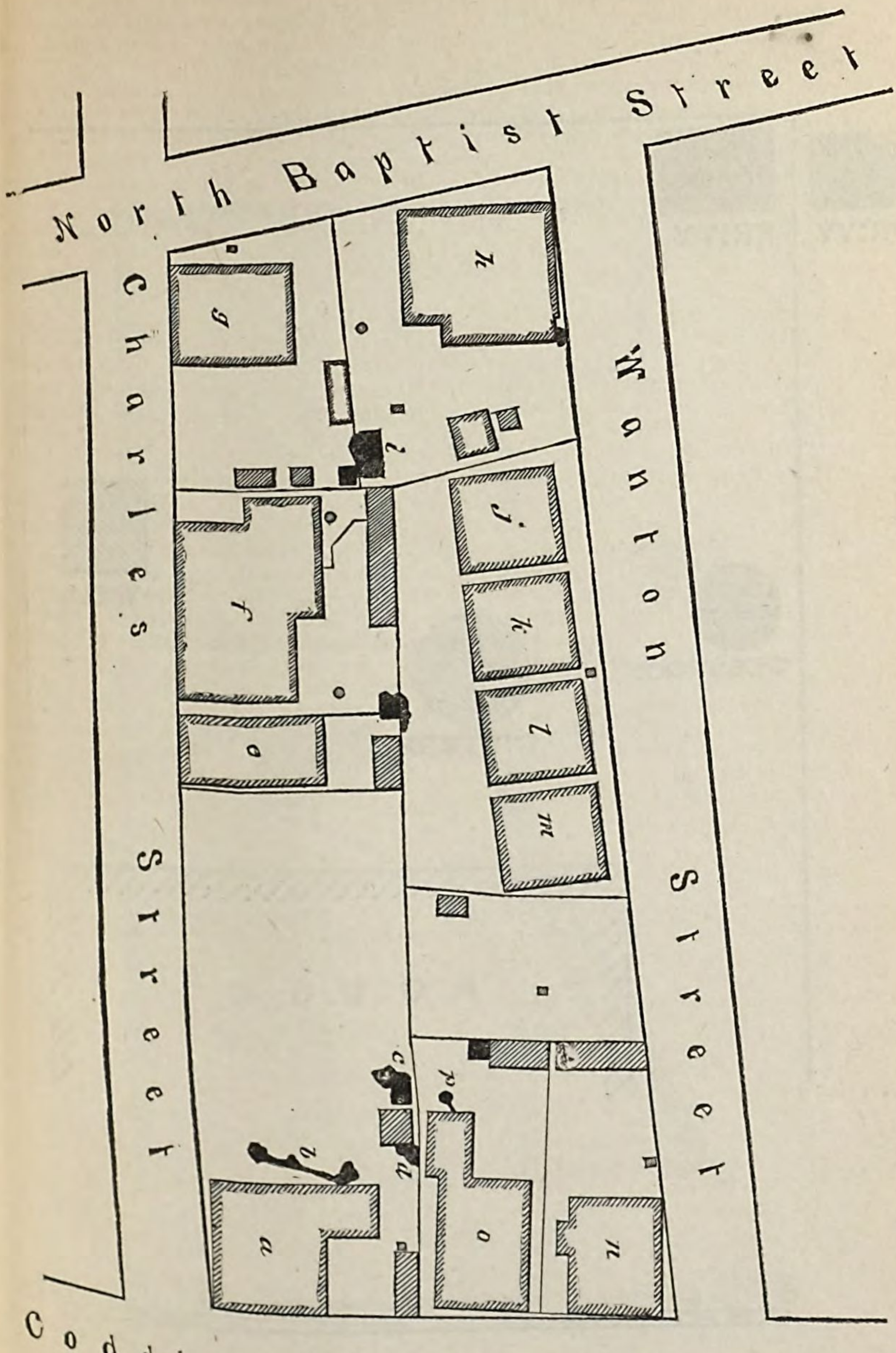
The surroundings of one school-house were highly objectionable and evidently had been for years. (It was afterwards ascertained that complaint had several times been made by the school board to the local board of health, but without success.)

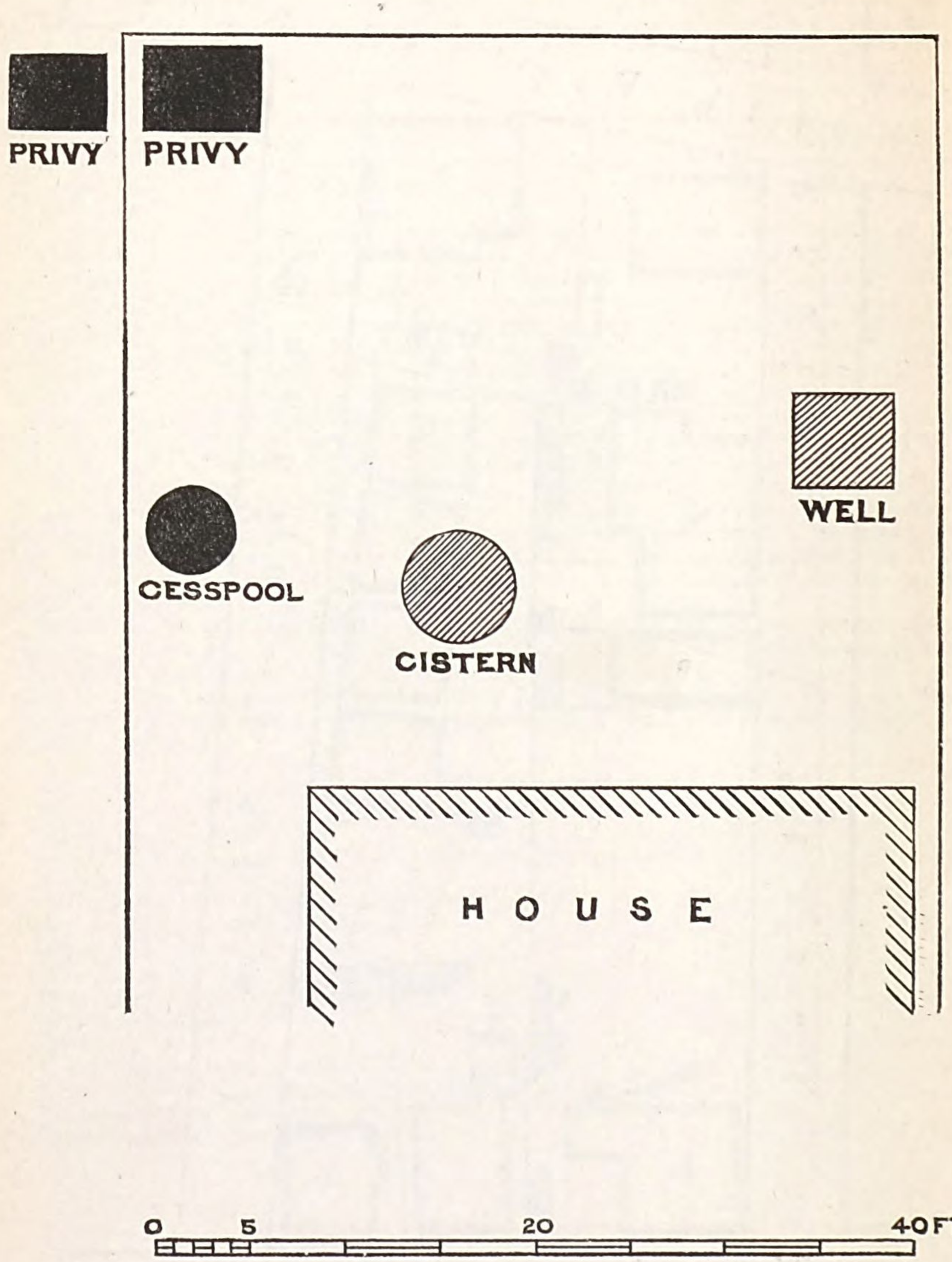
Not one of the dwellings, and by this it is to be understood their immediate surroundings are included, was in even fair condition, while several should have been vacated for sanitary reasons. It was possible of course that the houses examined did not represent a fair average, but these cases were reported to the full board early in July, 1881, and up to December 10 of the same year nothing is known to have been done except possibly at the school-house.

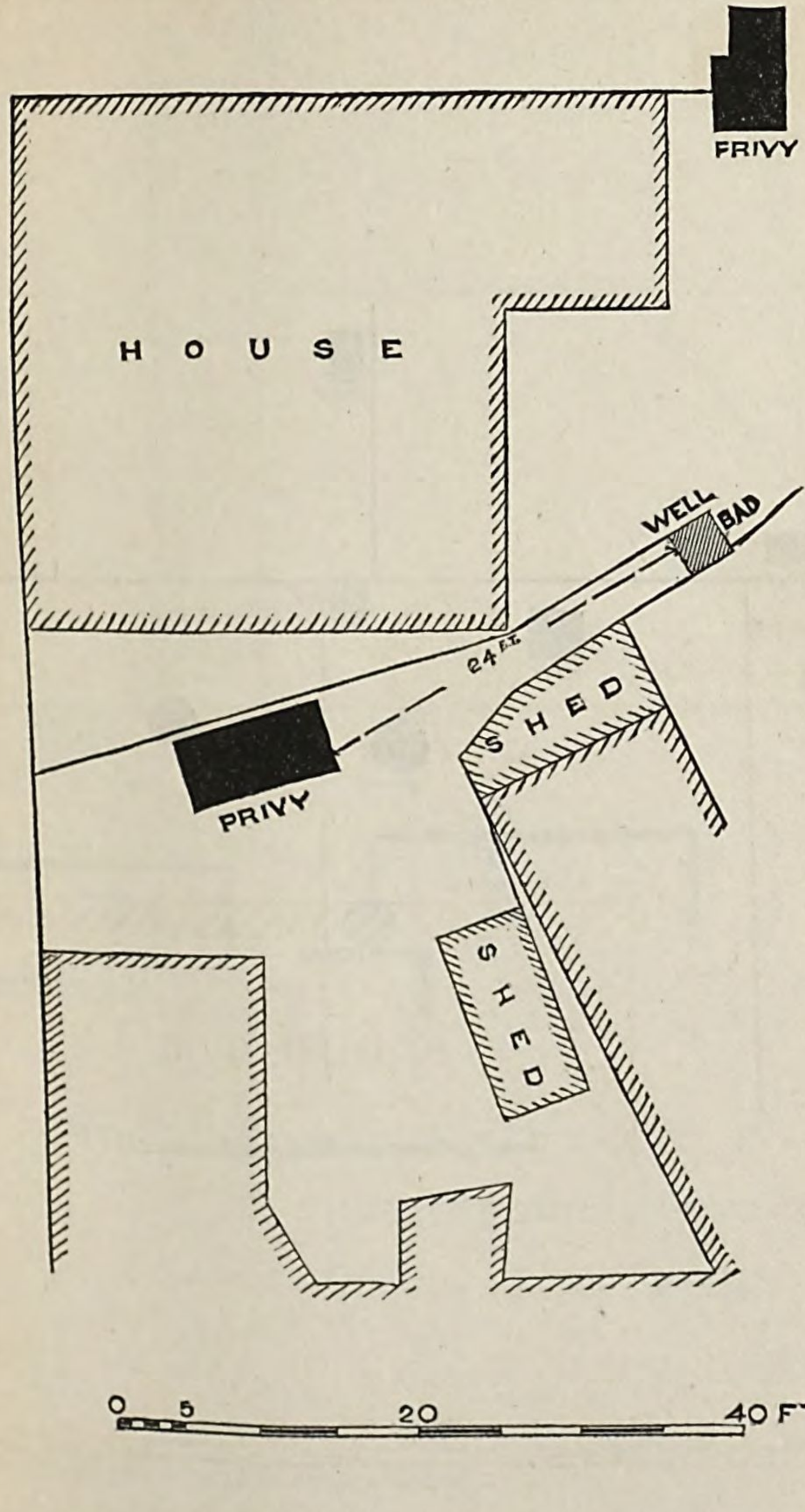
The house to house examination, made possible through the liberality of Newport's citizens, was conducted in such manner as to collect facts bearing on the public welfare rather than to ascertain the condition of plumbing, &c., in each and every house. In the inspection the accompanying form was made use of, it being a modification of what was used by the Massachusetts State board of health for the sanitary survey of Holyoke.

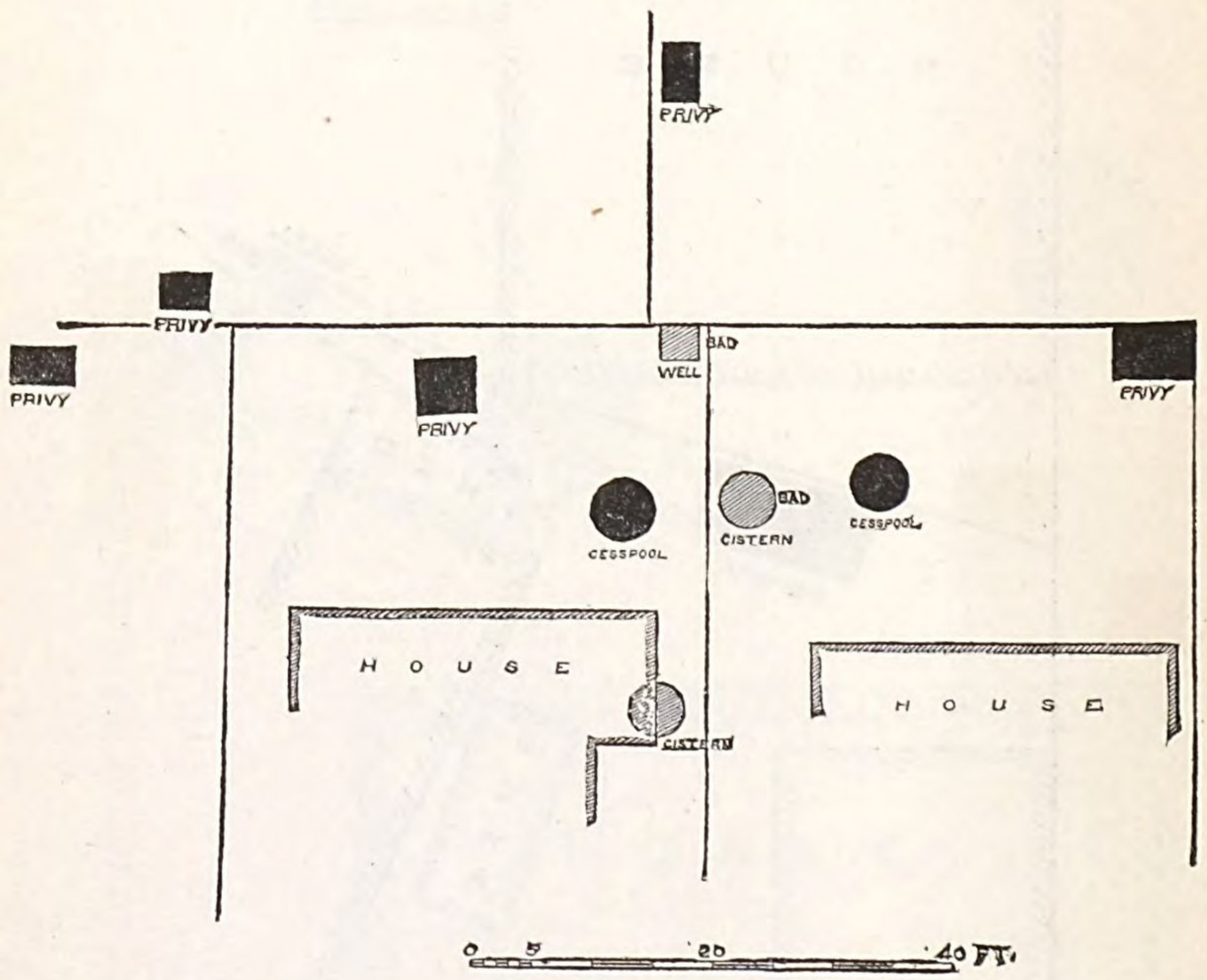
SANITARY SURVEY OF —— ——.

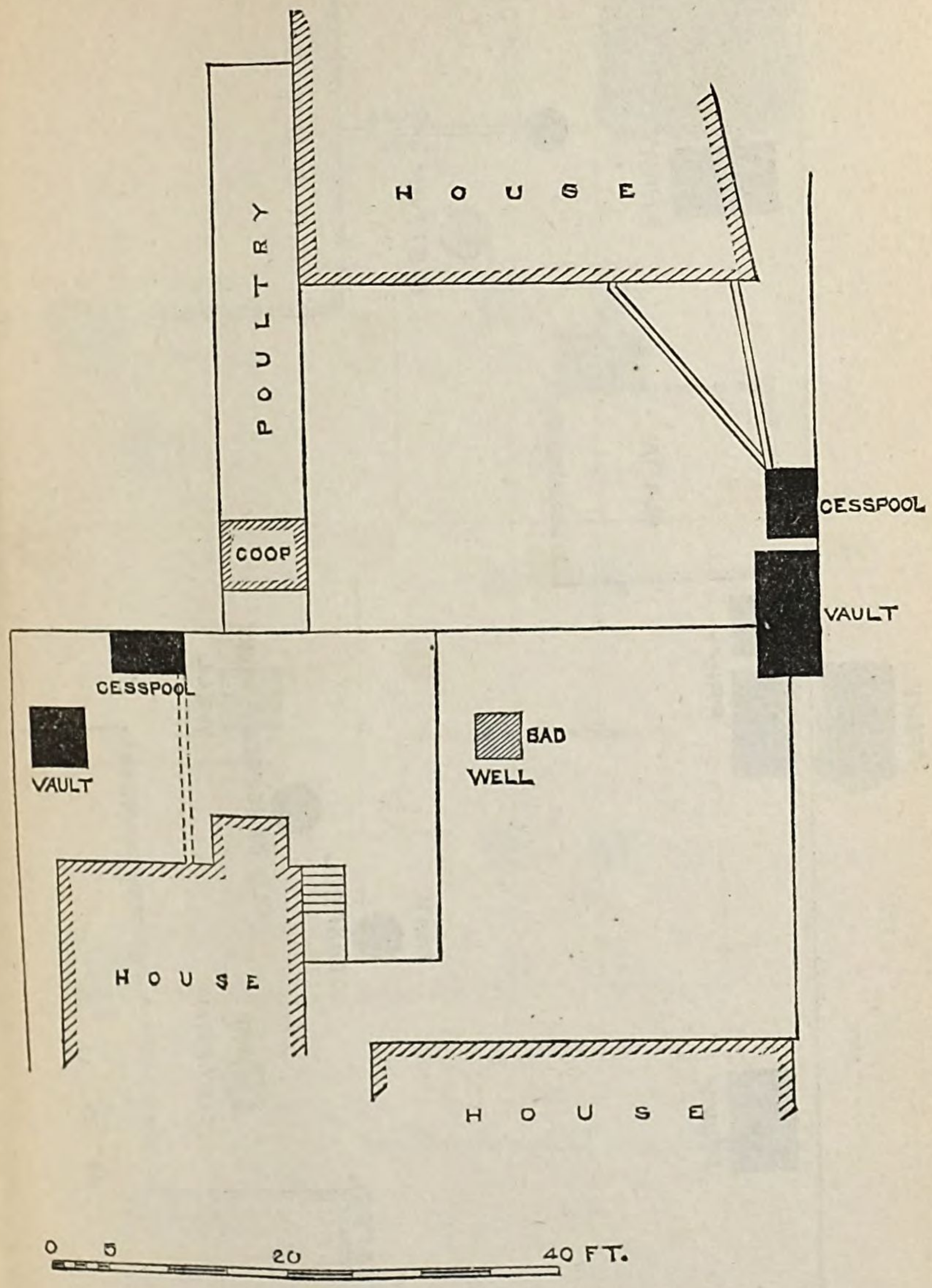
Street, ——; ward, ——.
Owner of Building, —— ——; occupied by —— families.
Names, —— ——.
Nationality, ——; cubic space sleeping, ——.
No. of adults, ——; children, ——.
Occupation of adults, ——.
Occupation of children, ——.
Description of privies, vaults, &c., ——.
Surface drainage, ——.
Garbage, ——.
Water supply, ——; cellars, ——.
Sewerage, ——; general surroundings ——.
Sickness during last year, ——.
Attending physician, —— ——.

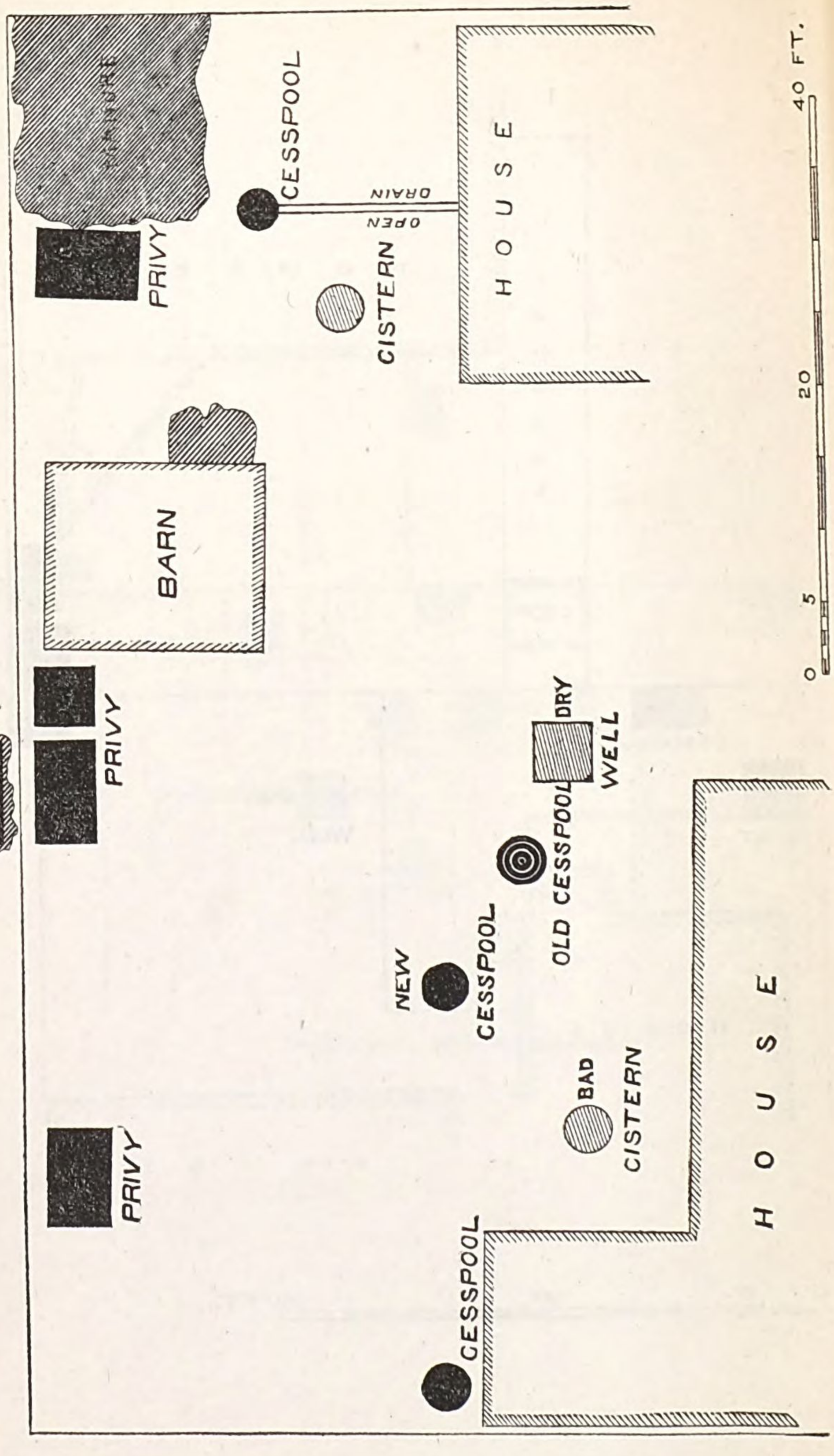

North Baptist Street
Church Lane
Union Street
Codd ington Street
a
b
c
d
e
f
g
h
i
k
l
m
n
o

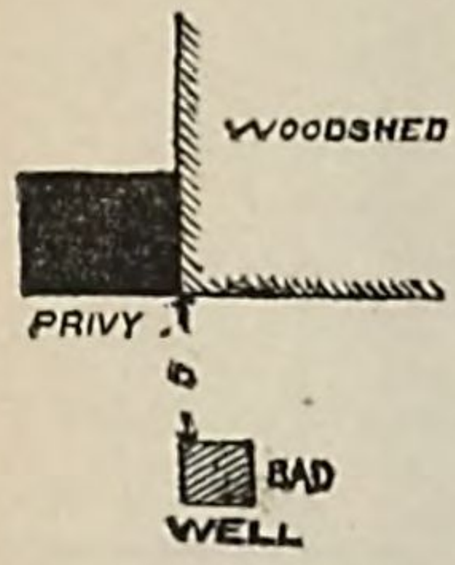

PRIVY
PRIVY
WELL
CESSPOOL
CISTERN
HOUSE
0
5
20
40 FT.

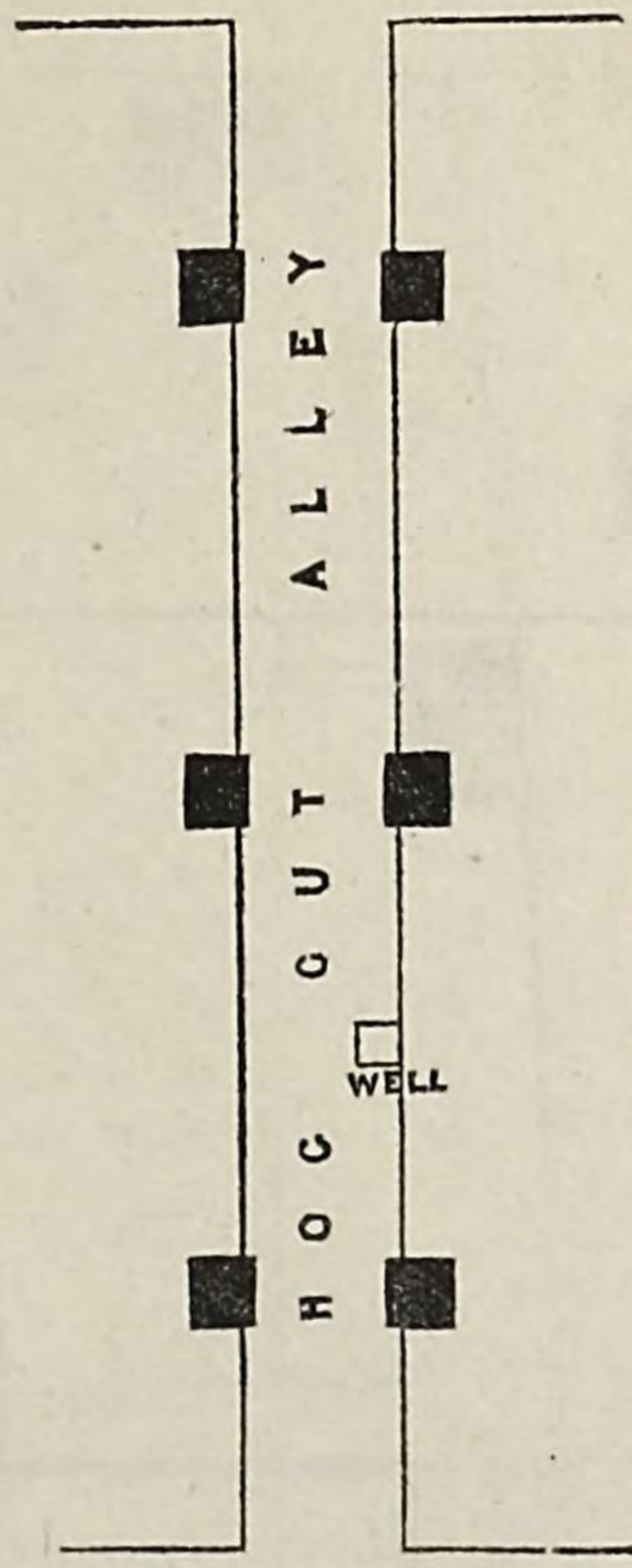

FRIVY
HOUSE
WELL
BAD
24 Ft.
SHED
PRIVY
SHED
0 5 20 40 FT.


PRIVY
PRIVY
PRIVY
PRIVY
PRIVY
WELL
BAD
PRIVY
CESSPOOL
BAD
CISTERN
CESSPOOL
HOUSE
CISTERN
HOUSE
0 5 20 40 FT.

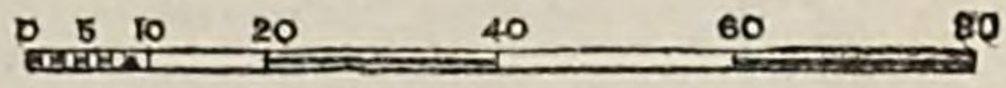

POULTRY
HOUSE
COOP
CESSPOOL
VAULT
CESSPOOL
VAULT
BAD
WELL
HOUSE
HOUSE
0 5 20 40 FT.

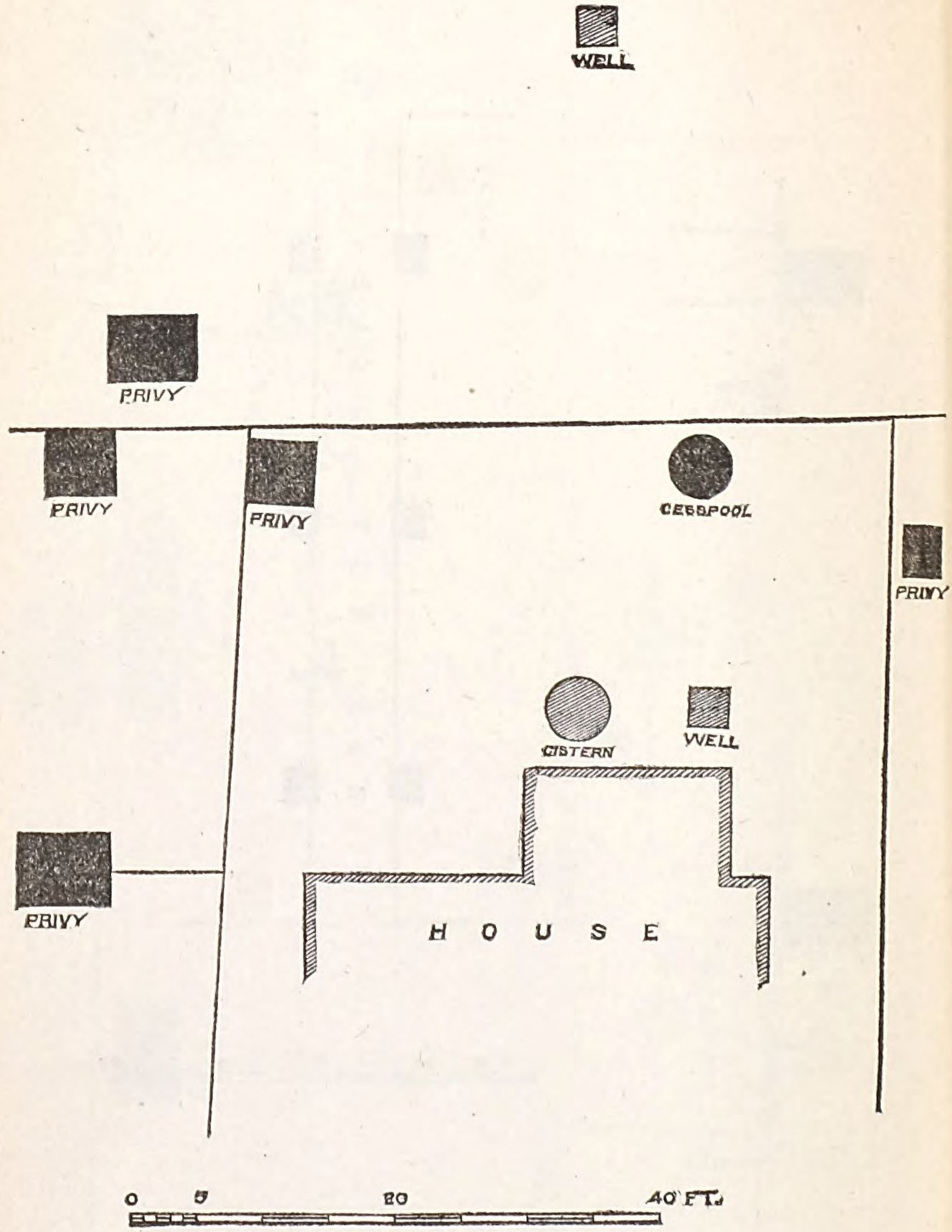

PRIVY
CESSPOOL
DRAIN
OPEN
HOUSE
40 FT.
PRIVY
CISTERN
OPEN
BARN
PRIVY
PRIVY
CESSPOOL
DRY
WELL
0
5
20
NEW
CESSPOOL
OLD CESSPOOL
BAD
CISTERN
PRIVY
HOUSE
CESSPOOL

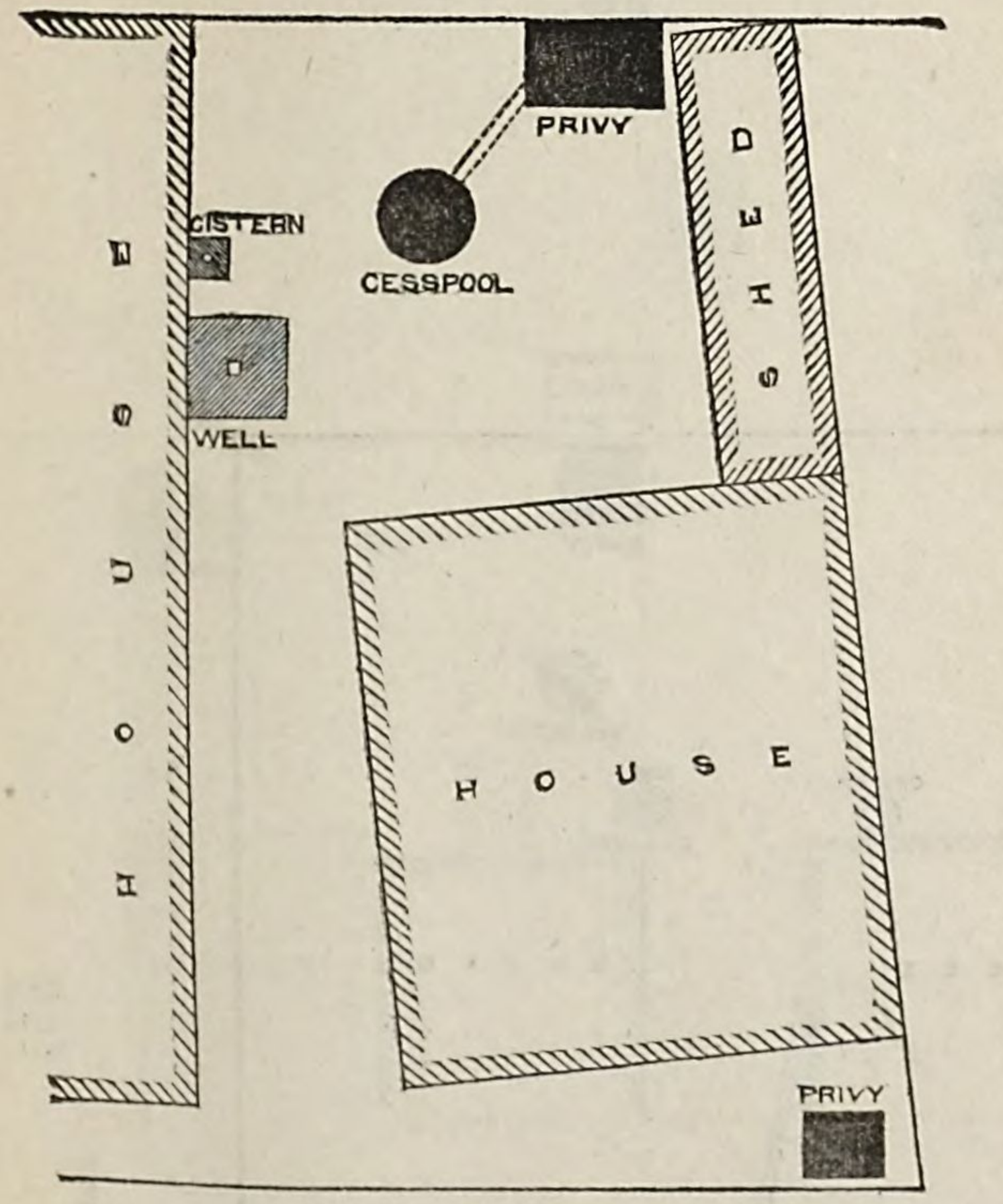

WOODSHED
PRIVY
6
BAD
WELL

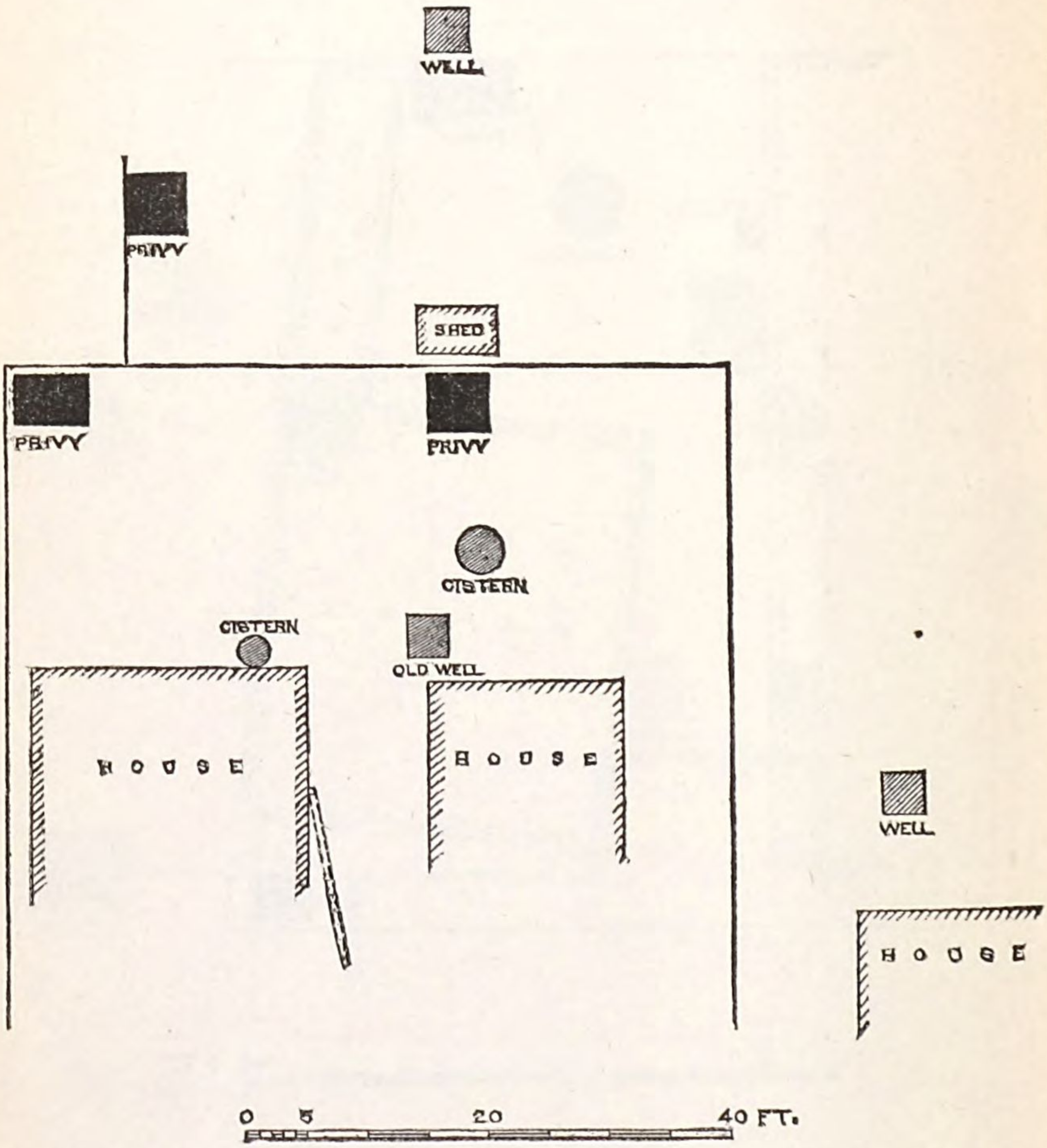

ALLEY
HOC CUT
WELL

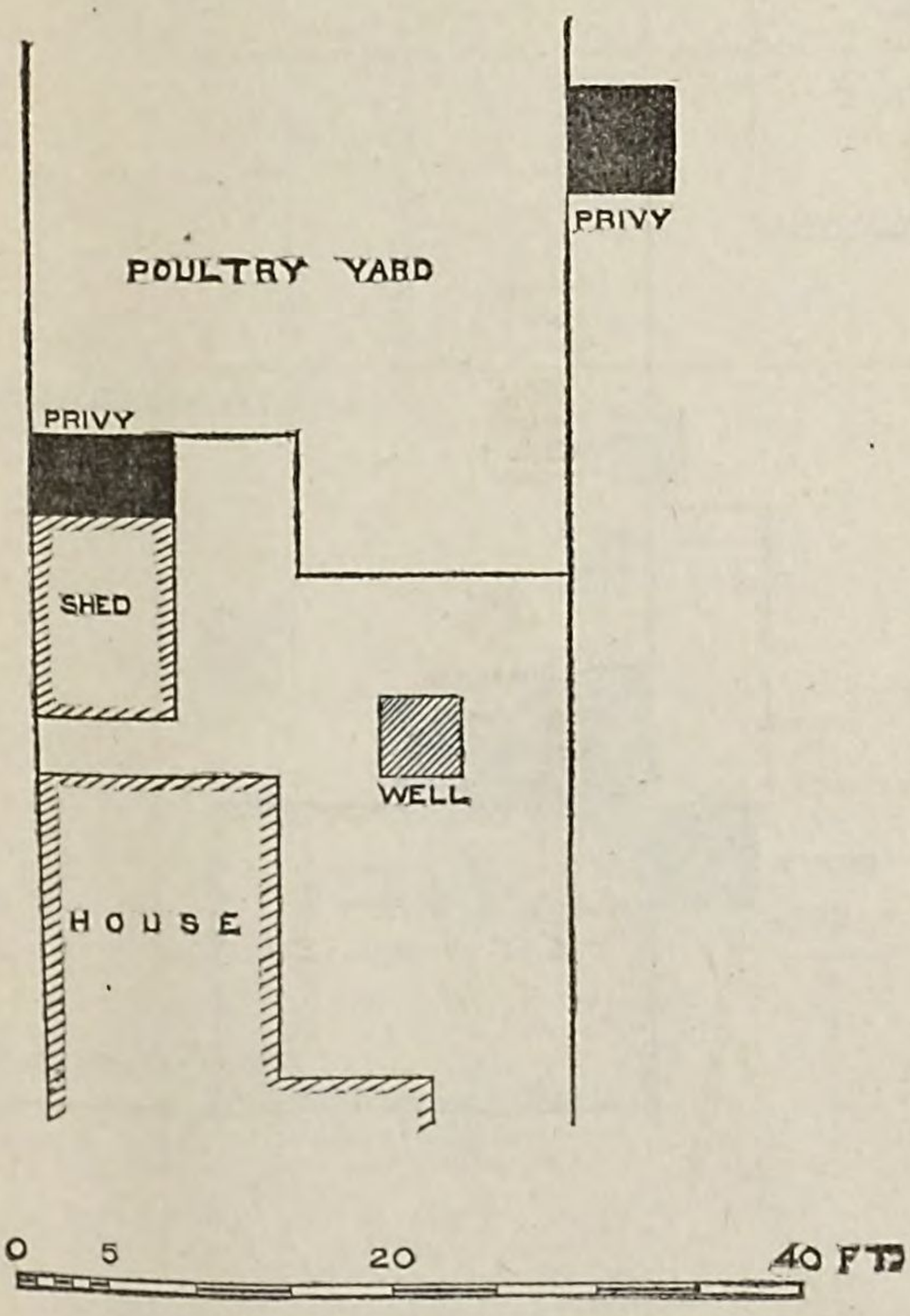
PRIVY
6
BAD
WELL

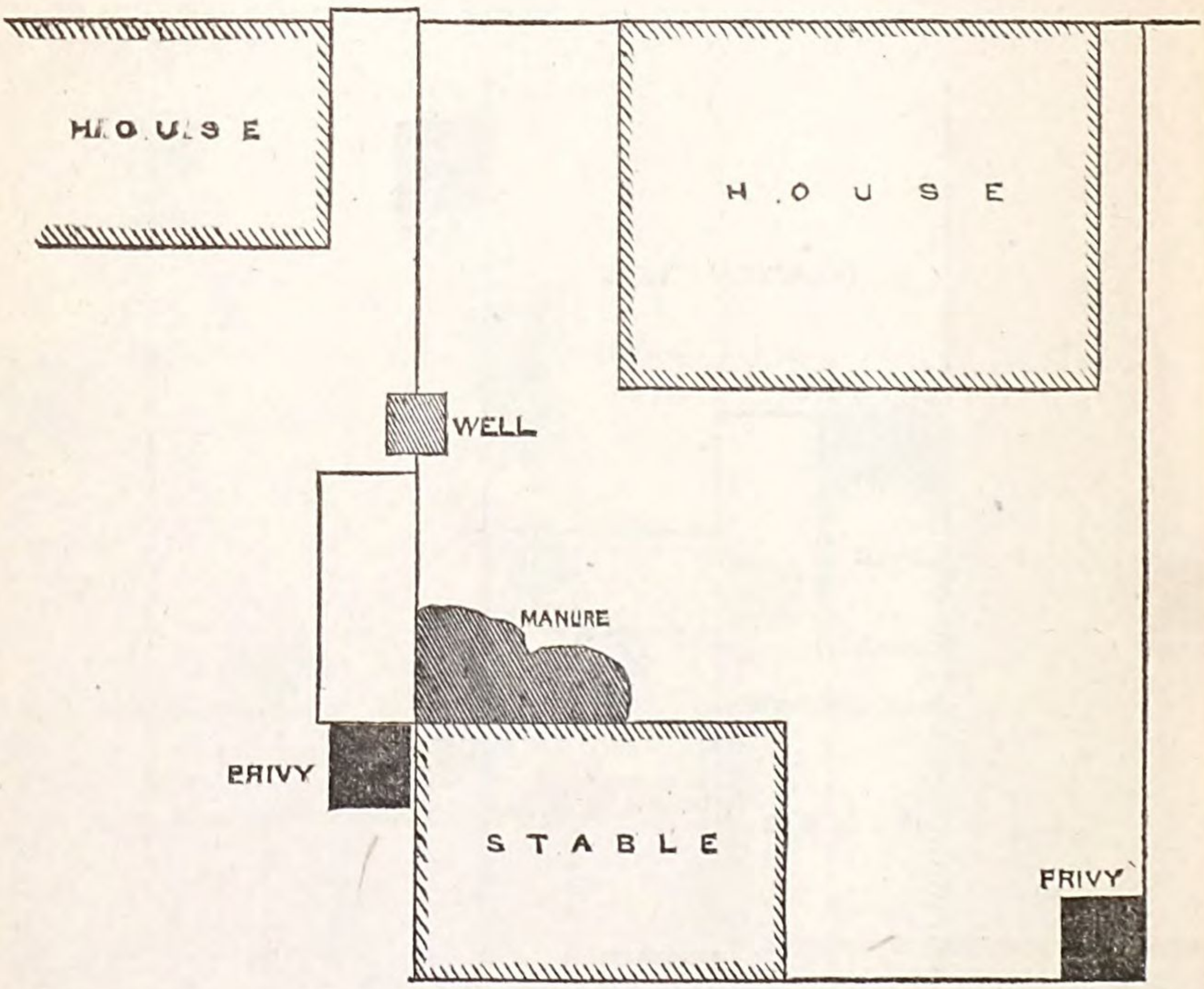

0 5 10 20 40 60 80

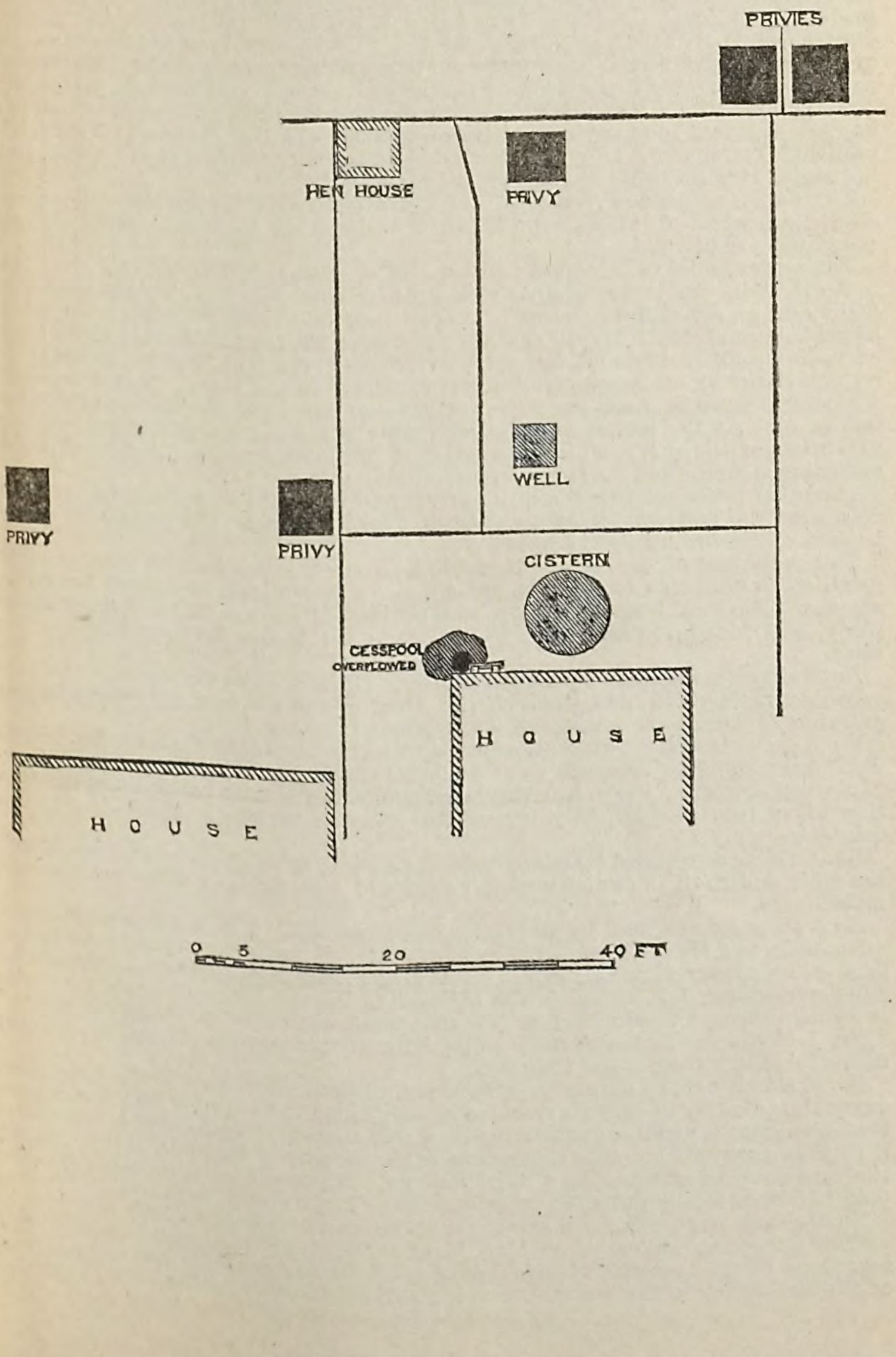

WELL
PRIVY
PRIVY
PRIVY
CESSPOOL
PRIVY
CISTERN
WELL
PRIVY
H O U S E
0
5
20
40 FT.


PRIVY
CISTERN
CESSPOOL
WELL
SHED
HOUSE
HOUSE
PRIVY
0 5 20 40 FT.


WELL
PRIVY
SHED
PRIVY
PRIVY
CISTERN
CISTERN
OLD WELL
HOUSE
HOUSE
WELL
HOUSE
0 5 20 40 FT.


PRIVY
POULTRY YARD
PRIVY
PRIVY
SHED
WELL
HOUSE
0 5 20 40 FT


HOUSE
HOUSE
WELL
MANURE
PRIVY
STABLE
PRIVY
0 5 20 40 FT


PRIVIES
HEN HOUSE
PRIVY
WELL
PRIVY
PRIVY
CISTERN
CESSPOOL
OVERFLOWED
HOUSE
HOUSE
0 5 20 40 FT

The results, for convenience, have been plotted in a series of charts, first giving statistics for each and every ward, and afterwards the same thing for the entire city. These are arranged in percentages, considering the perimeters of the circles to represent 100 per cent. in each case. The location of the different wards can be seen at a glance from the plan of the city. For instance, in Ward 1 about 18 per cent. of the cellars are bad; between 68 per cent. and 69 per cent. of the privies are out of order; 79 per cent. of the houses depend on wells and cisterns; 25 per cent. of the surface drainage is bad, &c.

In addition are shown individual cases of filthy surroundings, where sickness had either occurred just before the time of visit or there were cases of sickness then.

No. 1 represents a block bounded by Codington, Charles, North Baptist, and Wanton streets, to which attention was called accidentally by seeing a placard on a front door (*a*) warning people that diphtheria was present in the house. The visit was made July 14, 1881; the placard was dated July 5, 1881. The house was inhabited by twelve people, four adults and eight children. During 1880 there had been three cases of "fever and diphtheria, some one was always ailing, and now the little boy was sick again." There was a filthy puddle from the sink drain, over 30 feet long, parallel with and a few feet from the house (*b*), privy overflowing in two directions (*c*), and swill banked against the sunny side of the wood-shed (*d*). Had the board of health been notified? "Certainly, they put that label on the door." What else? "Why, nothing more; it wasn't safe to come on the premises."

The next two houses (*e* and *f*) are inhabited by six families, thirty-five people altogether, whose drinking supplies are a well and two hogshead cisterns. The surroundings are filthy.

The corner house (*g*) reported four cases of scarlatina in 1880, one case of low fever in April, 1881, "and two children sick on the second floor now." "The house is unlucky and we are going to leave." A brief inspection showed ample reason for the house being unlucky. House at corner of North Baptist and Wanton streets (*h*) has exceedingly filthy surroundings, privy overflowing, &c. (*i*). Next four stables (*j*, *k*, *l*, *m*), which are by all means the cleanest buildings in the block. Next a vacant lot. Then two houses between the corner of Wanton street and the first mentioned premises (*n o*). At the corner one the occupants were not communicative, and with exception of the privy, which was full, and the sink drain, which gave off a most sickening stench, the premises were reasonably tidy.

The other house comprised a filthy privy, and when the cess-pool cover (*p*) (tight) was lifted the material inclosed welled up over the surface, showing the sewage had backed up the drain into the house.

This is the last of the block. It would be entirely safe to say that every one of the dwellings within this area of two and a quarter acres should be vacated for sanitary reasons. The local board of health was notified of this condition of things at once (July, 1881), but up to December 10, 1881, it is not known that anything had been done.

No. 2 shows a well used by many families. Of its analysis the report is "Contains organic remains with indications of the proximity of the source of possible organic pollution, and is hence a water of a suspicious character."

No. 3 shows a well whose waters are supposed to be used by three families. "This well water would be returned as of doubtful character, basing the report on the organic matter alone; but when the large amount of organic remains is at the same time taken into account, only one opinion can be entertained: that it is unfit for a drinking supply."

No. 4 shows a well and a cistern used by several families, one unequivocally bad, the other doubtful. From an engineer's point of view the use of either would be very undesirable.

No. 5 shows a well used by more than one household. It is classed as suspicious.

No. 6 shows a cistern water used by one family, "a foul water, which should be condemned no matter what its origin. It is largely charged with recent organic matter, chiefly vegetable, but sewage is also believed to be present in small quantities." "It is probably from an open ditch or stagnant pond, or from an unusually foul cistern."

No. 7 shows two rather shallow wells, both private supplies. No one could for an instant consider them other than bad.

No. 8, a well used by a number of tenements, is thus reported: "In this water there exists the quantity of organic remains usually found in Newport wells. The organic matter present is small, but the amount of free ammonia should condemn this water, if there is any probable polluting source in the vicinity of the well. If there is none the water may be accepted as of fair quality." The reader can be the judge from the plan "if there is any probable polluting source in the vicinity of the well."

No. 9 shows two wells, both private supplies, and both unequivocally bad.

Water supplies indicated on Nos. 10, 11, 12, 13, 14 are pronounced unsafe to use, regardless of their possible chemical analysis to the contrary. With so many sources of contamination in the immediate neighborhood no other conclusion is admissible.

Water was taken for analysis from various wells (mostly common to at least two families) supposed from the surroundings to be undesirable; the record fully confirms the opinion. Besides these, several samples were taken at the request of householders, though as a rule there was little interest shown by citizens in the condition of the drinking supplies.

The accompanying chart shows the whole list of water analyses (except Easton pond water) at a glance, arranged so as to give the chemist's report entire, with the exception of the written conclusions arrived at, which it would be impossible to show at length in such small space. In addition, the city supply has been analyzed periodically from November 9, 1881, to August 14, 1882, in order that a continuous record could be given of the condition of the city water during the months of the year when ponds and streams should be purest.

Analyses were made exclusively by Dr. Charles Smart, United States Army, and his comments on the city water are given in full. It is deplored that one object of the examination (of helping in every way to better the existing state of things) was so entirely misinterpreted by the water company that all suggestions proved largely of negative value, but it has rendered necessary, perhaps, a more careful examination and cumulative chemical testimony, that may prove of value to summer guests, than would otherwise have been indulged in.

Dr. Smart says of the first sample of city water ("Newport No. 5") drawn from the faucet in city clerk's office November 9, 1881: "This seems to be a surface water, which has gathered much impure material in its course. Few river waters which are not open sewers exceed it in impurity. The matter is mainly vegetable and in process of change, but it is not entirely so.

"Vegetable matters in water are conceived to be less dangerous, weight for weight, than animal substances, and less prone to be accompanied by specific poisons; but all the items on this record are in excess of the figures considered allowable by even the least cautious of specialists. I can instance numerous cases where water of this character has been productive of what is usually called typho-malarial fever." Dr. Smart was unaware of the source of this water.

Assuming that "Newport No. 5" might not, for some reason or other, be a fair sample of what was supplied to consumers, another sample was taken, from the public drinking fountain in front of the Perry House (Newport No. 35). Of this, Dr. Smart says: "This water is foul and unfit for use, on account of an excess of recent vegetable matter. It may be derived from a marsh or pond, or from a cistern into which the organic matter does not filter, but arrives by direct channels, as along the roots of trees or by inflow from the surface." Dr. Smart was unaware of the source of this water.

As many customers use filters, attached to their faucets, still a third sample was taken from the city clerk's office, interposing a Grant revolving filter.

"Newport No. 70" is thus pronounced by the chemist: "This is no doubt the Newport general supply after filtration; improved by the filtration only in so far as the removal of minute solid particles is concerned. Practically the water is unimproved."

Consultation with the principal owner in the water company elicited the statement that the water main from which samples had been taken was what is technically called a "dead end" (where there is no circulation in the pipes), and that the passage of water through the pipes rendered it foul. It was suggested that if samples be taken for analysis from the reservoir or pond chemical results would be more satisfactory. December 24, 1881, samples were taken from both reservoir and pond (Newport Nos. 71 and 72), which provoked the following comments: "Had the origin of these waters been unknown, the analyst would have reported them in terms similar to those used with reference to Nos. 5 and 35 Newport. But as he is aware of the origin, the opinion is of necessity that both waters are excessively foul and unfit for use, and this at a season when surface waters are generally at their purest."

Further consultation with the water authorities developing a policy of passive resistance to any change whatever, on March 20, 1882, simultaneous samples were taken from reservoir, pond, and public fountain previously referred to, with the idea of continuing the same periodically to obtain thorough knowledge of the water throughout several months.

Of the first three samples taken upon this basis, Nos. 100, 101, and 102, the report is: "These results show the presence of a large amount of vegetable matter, sufficient in quantity to render the waters unsuitable for a general supply."

Nos. 103, 104, and 105, taken April 5, Nos. 106, 107, and 108, April 27, have no comments whatever. Of Nos. 109, 110, 111, taken May 12, 1882, "the organic matter is chiefly vegetable and in a putrescent state, especially in 109 and 110" (reservoir and pond). Nos. 112, 113, and 114, taken June 1, 1882, "vegetable matter in a putrescent state in all; markedly so in 113" (pond). Nos. 115, 116, 117, taken June 21, 1882, show the following: "117 appears to have got rid of some of the grosser particles which give the haziness or turbidity, probably by undergoing a slight sedimentation. In 116 especially the organic matter is recognizable without the microscope as portions of

dead insects, living mosquito larvæ, &c. These are neither more nor less than ditch waters."

Nos. 118, 119, 120, taken August 14, 1882, are commented on as follows: "Analysts and doctors sometimes fail to agree on the opinion to be deduced from the record of an analysis. I scarcely think there is room for a difference of opinion on the quality of these specimens. If these are good waters, analysts may break up their retorts and retire from business until new methods have been discovered or until it is demonstrated that any vegetable solution will do for a city water supply."

Upon these analyses it seems as if the city water as at present offered to the public is decidedly unwholesome. It should be stated that none of the changes suggested by the water authorities appear to be in the least adequate to meet the difficulty. It is not likely the charcoal filters proposed (intended to work horizontally) will filter more than a portion of the water, because the charcoal will settle and allow part to flow over the top. It should be stated, too, that the effect of the pipes upon the water is precisely opposite from what was claimed—the water being appreciably better after passing through; and this is fortunate, for even had it been proved that the water at the pond was perfectly good while that from the pipes was unequivocally bad, it could scarcely be expected that water takers would avail themselves of this knowledge and go to the pond whenever a pailful was desired.

Usually water is classed as "excellent," "very good," "fair," "permissible," "suspicious," "very suspicious," or "bad," according as the analysis and surroundings may show. The city waters can only be classed as permissible for sample No. 105, all others being below that standard.

The city (Easton pond) water chart is arranged so that it is easily seen when the water was least unwholesome and, as one would suppose, it happens at the time of the year when ponds are fullest from spring rains and thaws; in other words, impurities are more diluted then than at other times.

During the examination instances of filthy premises were brought to notice that deserve special attention, not only from being hideously foul, but because the attention of the local board had been called to them without avail.

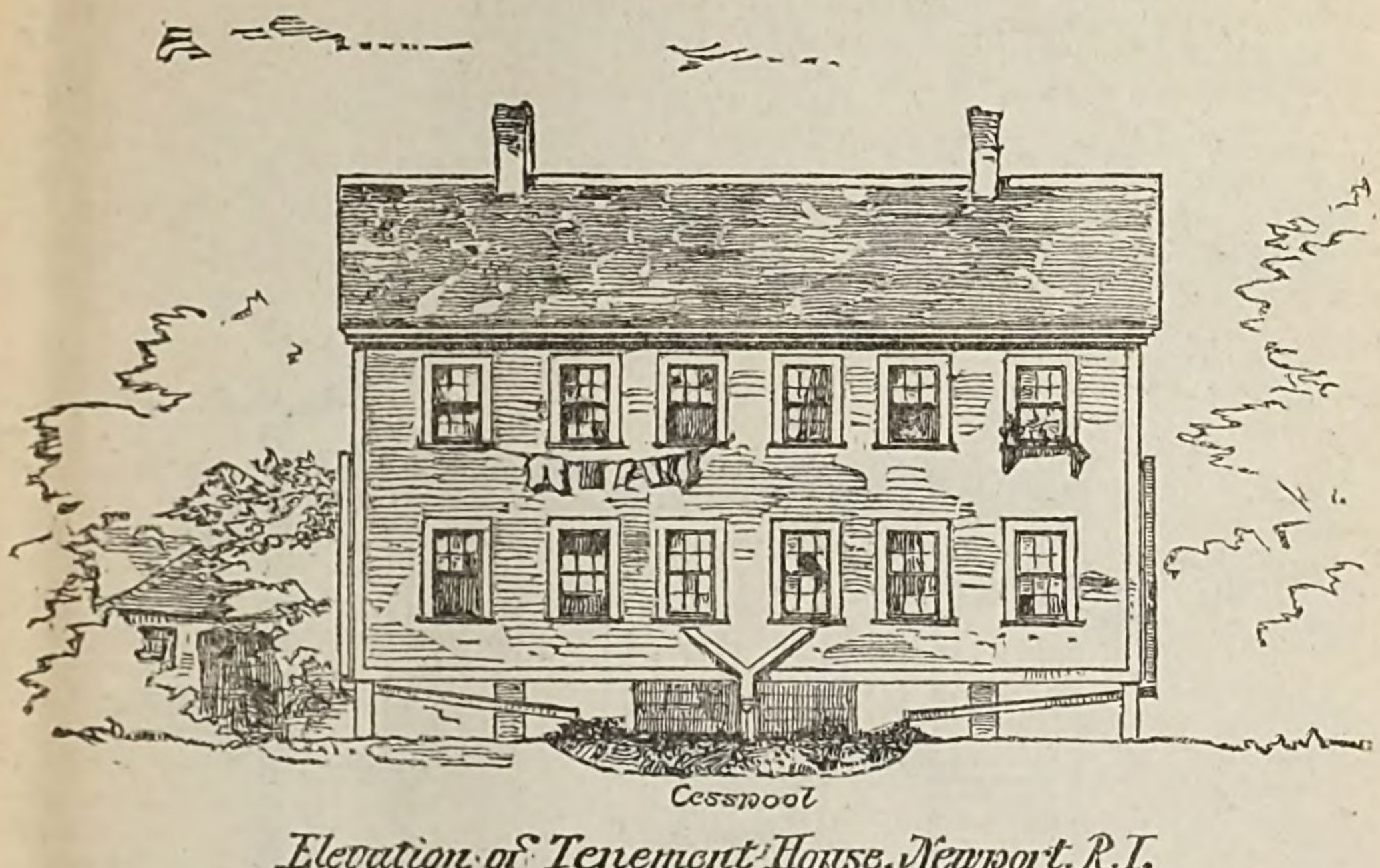
The first, as shown on drawing (not an exact copy for obvious reasons), a tenement house supported a few feet above the ground on piles. Four families occupy the building, two on the ground floor and two above. They take borders. Four kitchen sinks and a privy constitute the sanitary comforts. The cess-pool is merely a shallow depression in the earth, without cover, under the center of the building, into which empty four **V**-shaped wooden drains; a writhing mass of maggots and a corresponding nauseating smell reminds one that the cesspool needs attention. First floor tenants are asked when it was cleaned out last, and the answer comes to the effect that it never has been during their inhabitation of the premises; the family intends to leave directly—have been living there a year and a half and "some one ailing all the time." The privy is full and overflowing, and has evidently been for some time back. A member of the board of health informs the writer that he can show him a dozen just such places or worse.

Next, attention is called to a small building on a principal street by seeing sewage either oozing up through the brick of the sidewalk or issuing from the side of a house, through the cracks of the woodwork. The first floor is a restaurant. "Can the inspector go down cellar"? "No, sir; look here;" at which a section of the floor (the room is covered with a thick Brussels carpet to keep down the smell and dampness) is taken up, disclosing a small sea of sewage, covering the entire cellar to a depth, at the time of visit, of 3 feet, and on the surface of which floated discs of what seemed to be a sort of mold or fungoid growth of some description. From the sides of the trap-door was suspended a frame in which it is customary to deposit beer and food to keep cool. A number of large lazy blue flies are found clinging to the underside of the trap-door, which appeared suggestive. One case of diphtheria in the house at the time of visit. Statement was made by the proprietor that he had more than once spoken to the chairman of the board of health and to the health officer, and both of them had been over and inspected the premises, but had declined to take action.

Bearing in mind that city water is undesirable to use, that perhaps a majority of the wells are already tainted, and that the sewer system is practically of little or no value, save to concentrate nuisances at certain points, that no precaution is taken against zymotic diseases except to placard front doors, the apparent freedom of the city from preventable sickness is remarkable.

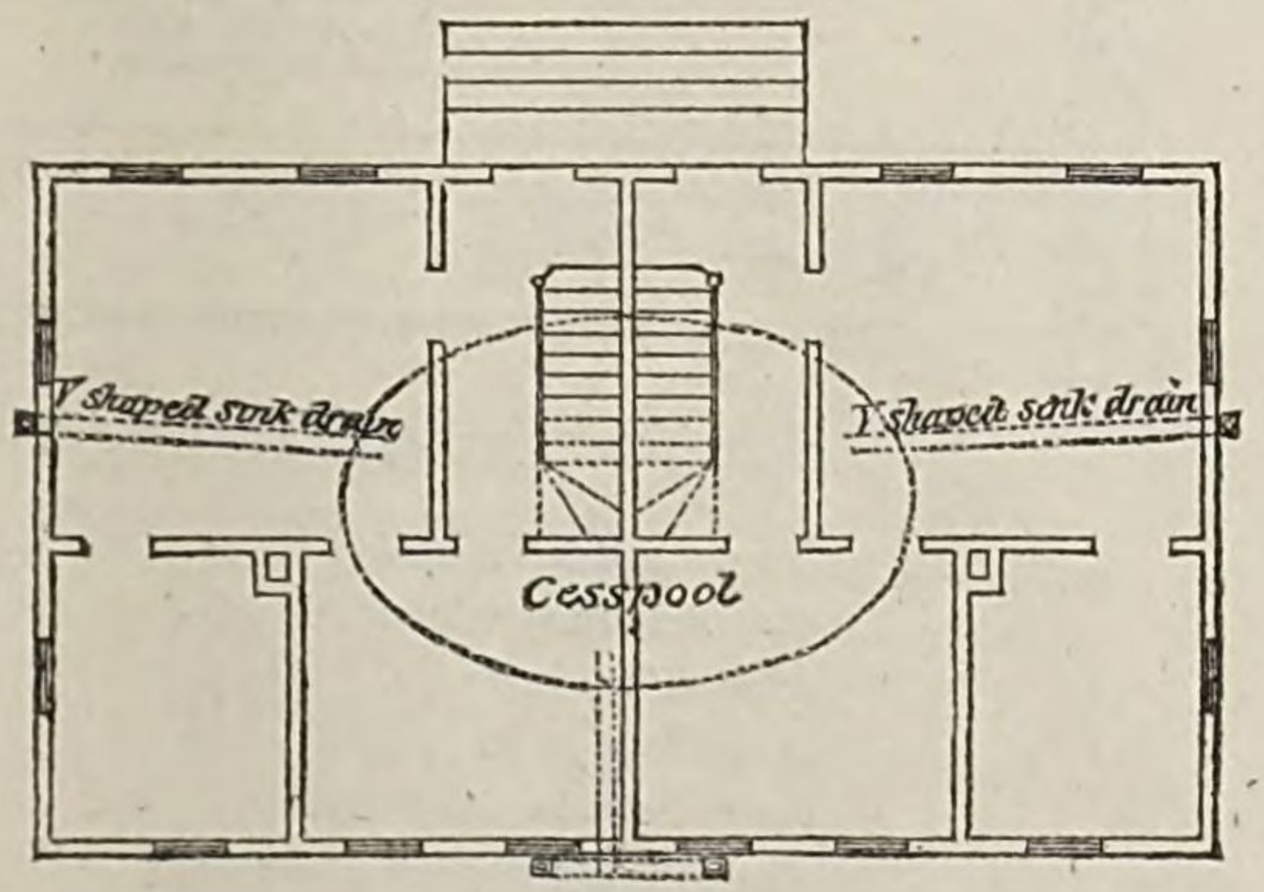
It is questionable, however, whether the health of the city is known to any one; with the exception of a few of the citizens it is undoubtedly so, and it would be entirely safe to assert that neither the local board of health nor their officer knows at any time the actual health of the community, or anything approaching it, while the records show nothing.

It is not proper to draw comparisons between the sanitary condition of Newport and that of other places visited, as at no other resort were house to house examinations

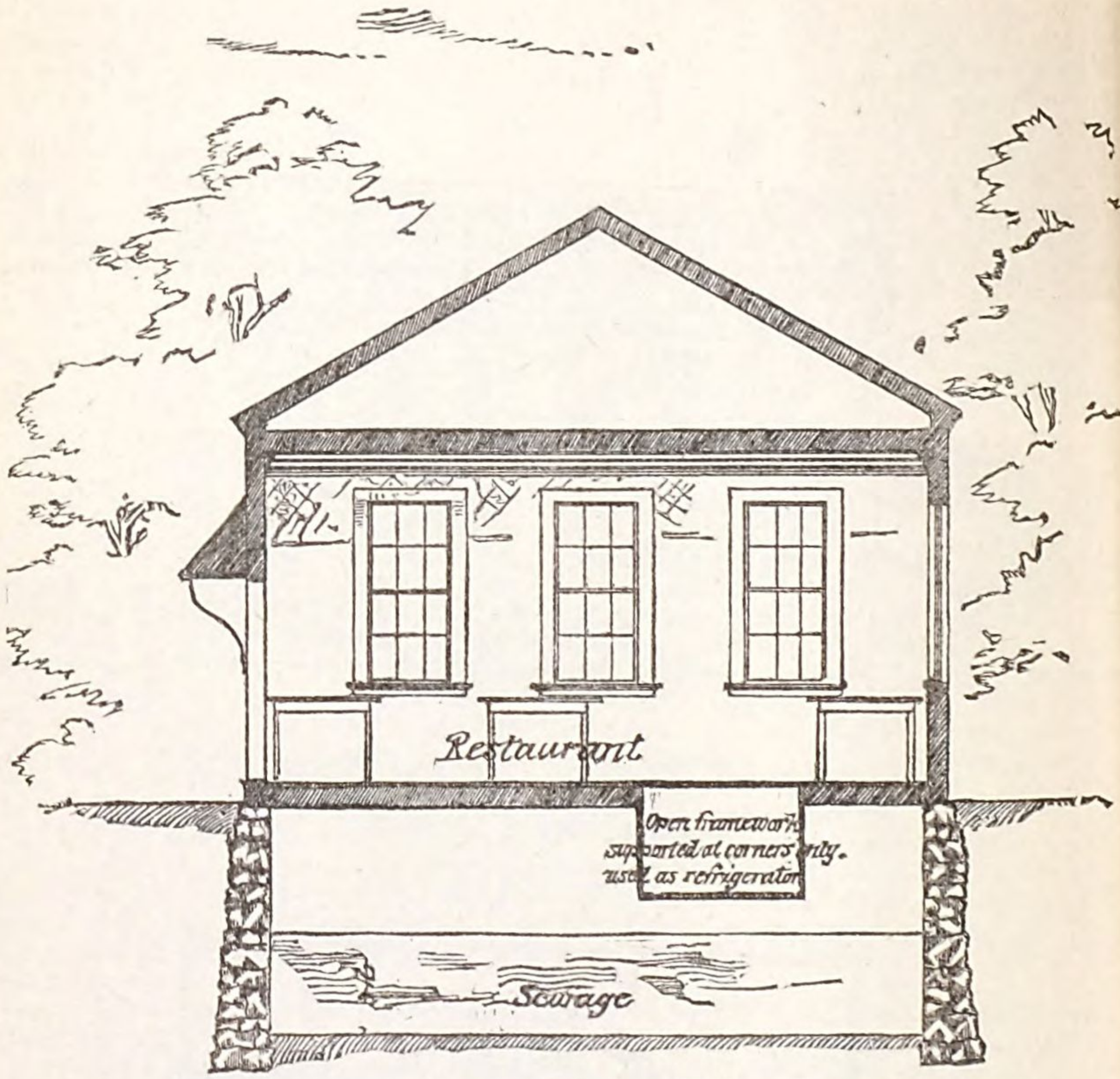


Elevation of Tenement House, Newport, R.I.

"Someone ailing all the time"



Plan



Section through Restaurant.

Privy vault full of water.
Surface drainage bad
City water used
3 ft. of sewage in cellar.
General surroundings bad.
One case of Diphtheria last year.

possible, but it is wholly within bounds to say that the more thickly settled wards of Newport are not desirable as places of residence, and that the quality of water collected from clean roofs, stored in properly built tight cisterns, and filtered before use, is likely to prove more satisfactory for drinking and cooking than other possible supplies.

Till quite recently Newport has been classed merely as a summer resort; it is now, however, both a summer and winter watering place, a health resort; and while it is perfectly possible for summer watering places to use leaching cess-pools, open privies, and undesirable surroundings during three or four months (allowing eight or nine months for recovery) with reasonable safety, yet it must be evident that when these same conveniences and surroundings are in constant use the year round, the conditions may be widely different and much less desirable.

How long this condition of things will be permitted to exist it is impossible to tell, but until some epidemic occurs, an outbreak that may damage the city so that it will take years to recover, it is doubtful whether any radical change will be made. Plans for systems of sewers have been drawn by eminent engineers, treating that subject exhaustively, yet nothing is done owing to what is called the "conservative" temperament of the city government.

NEWPORT

[Under head of "kind of supply," "city" means water from Easton's Pond, "public" where it is
In the last column, those samples pronounced "very suspicious or bad," are shown with a double
cellent," being written in full. In two cases, the writer, from his knowledge of the surroundings, has

Number.	Collected.	Analyzed.	Transparency.	Color.	Odor.	Organic.	Inorganic.	Total solids.
	1881.	1881.						
1	Nov. 7	Nov. 9	Clear	None	None	27.0	99.00	126.0
2	Nov. 7	Nov. 9	....do	....do	....do	17.0	63.00	80.0
3	Nov. 8	Nov. 10	....do	....do	....do	14.0	38.50	52.5
4	Nov. 8	Nov. 10	....do	....do	....do	25.0	54.00	79.0
5	Nov. 9	Nov. 11	Slightly hazy	Faintly yellow	....do	7.0	8.00	15.0
6	Nov. 9	Nov. 11	Clear	None	....do	13.0	44.00	57.0
7	Nov. 10	Nov. 12	....do	....do	....do	26.0	71.00	97.0
8	Nov. 10	Nov. 12	....do	....do	....do	13.0	52.00	65.0
9	Nov. 11	Nov. 14	....do	....do	....do	27.0	46.00	73.0
10	Nov. 11	Nov. 14	....do	....do	....do	33.0	40.00	73.0
11	Nov. 12	Nov. 15	....do	....do	....do	11.0	39.00	50.0
12	Nov. 12	Nov. 15	....do	....do	....do	16.0	32.00	48.0
13	Nov. 14	Nov. 16	....do	....do	....do	13.0	18.00	31.0
14	Nov. 14	Nov. 16	....do	....do	....do	31.0	47.00	78.0
15	Nov. 15	Nov. 17	....do	....do	....do	22.0	42.00	64.0
16	Nov. 15	Nov. 17	....do	....do	....do	34.0	88.00	122.0
17	Nov. 16	Nov. 18	....do	....do	....do	38.0	61.00	99.0
18	Nov. 16	Nov. 18	....do	....do	....do	3.0	15.00	18.0
19	Nov. 17	Nov. 19	....do	....do	....do	27.5	118.00	145.5
20	Nov. 17	Nov. 19	....do	....do	....do	11.0	98.00	109.0
21	Nov. 18	Nov. 23	....do	....do	....do	24.0	51.00	75.0
22	Nov. 18	Nov. 23	....do	....do	....do	14.0	21.00	35.0
23	Nov. 19	Nov. 23	....do	....do	....do	22.0	58.00	80.0
24	Nov. 19	Nov. 23	....do	....do	....do	27.5	60.00	87.5
25	Nov. 21	Nov. 24	....do	....do	....do	11.0	109.00	120.0
26	Nov. 21	Nov. 24	....do	....do	....do	32.0	130.00	162.0
27	Nov. 22	Nov. 25	....do	....do	....do	21.0	41.00	62.0
28	Nov. 22	Nov. 25	....do	....do	....do	27.0	66.00	93.0
29	Nov. 23	Nov. 26	....do	....do	....do	20.5	53.00	73.5
30	Nov. 23	Nov. 26	....do	....do	....do	30.0	87.00	117.0
31	Nov. 28	Dec. 1	....do	....do	....do	26.0	91.00	117.0
32	Nov. 28	Dec. 1	....do	....do	....do	15.0	34.00	49.0
33	Nov. 28	Dec. 1	....do	Faint tinge of yellow	....do	7.0	44.00	51.0
34	Nov. 28	Dec. 1	....do	None	....do	37.0	43.00	80.0
35	Nov. 29	Dec. 2	Faintly hazy	Slightly yellow	....do	5.50	6.00	11.5

DRINKING WATERS.

supposed to be used by more than one family, and "private" when used by one household only. dagger, ‡ those classed as "suspicious" by a single dagger, † the "permissible," "good," and "ex- classed water as "very suspicious or bad," while the chemist has adopted *a*.]

Kind of supply.	Chlorine.	Nitrous acid.	Nitric acid.	Oxygen required.	Free ammonia.	Albuminoid ammonia.	Characteristics.	Number.
Public ..	34.40	None ...	Present.	.1675	.1695	.010	Darkening slight; nitrous odor marked.‡	1
...do	17.20	...do	...do	.1428	.0025	.0085	Darkening faint; nitrous odor marked.†	2
...do	10.4	..do	...do	.0197	.0125	.0074	Darkening slight; nitrous odor marked.†	3
Private.	10.4	...do	...do	.1083	.0045	.0105	Darkening slight; nitrous odor marked.†	4
City	2.7	...do	Trace only.	.7042	.0100	.0680	Black patches, difficult to dissipate; slight nitrogenous fumes.‡	5
Public ..	9.6	...do	Present.	.0689	.0045	.0070	Darkening slight; slight nitrous odor. Permissible.	6
.. do	10.0	...do	...do	.1773	.0060	.0130	Darkening slight; nitrous odor marked.†	7
Private.	17.2	...do	Trace...	.1773	.0165	.09	Dark fawn color, dissipated slowly; no fumes; odor slight.‡	8
Public ..	14.4	...do ...	Present	.1726	.008	.0165	Darkening slight; dusky yellow, with strong nitrous odors.‡	9
...do	12.6	...do	...do	.0197	.005	.005	Darkening slight; nitrous odors strong. Permissible.	10
...do	8.0	.. do	...do	.0640	.018	.0075	Darkening slight; odor nitrous.‡	11
...do	8.0	..do	...do	.0147	.012	.0055	Darkening slight; odor nitrous.†	12
...do	4.8	...do ...	...do	.1477	.005	.0067	Darkening slight; odor nitrous. Permissible.	13
...do	12.0	...do	...do	.0492	.0175	.0052	Darkening slight; nitrous odor present.‡	14
...do	9.2	...do	...do	.0738	.0115	.0095	Darkening slight; nitrous odor marked.†	15
...do ...	21.6	...do	...do	.1872	.0025	.0155	Tawny yellow, and strong nitrous odor.‡	16
...do	10.0	...do	...do	.0788	.0015	.0105	Dark yellow, difficult to dissipate; nitrous odor strong.†	17
Private.	2.9	.. do	...do	.0394	.001	.0025	Film almost unaltered. Excellent.	18
Public ..	38.8	...do	...do ...	.1477	.0800	.0125	Dark film, difficult to dissipate; nitrous odor strong.‡	19
...do	26.8	.. do	...do	.1640	.0010	.0070	Darkening slight; nitrous odors present. Permissible.	20
...do	15.2	...do	...do	.0442	.0225	.009	Darkening slight; nitrous odors strong.‡	21
...do	4.80	...do	...do	.0345	.0140	.907	Darkening slight; nitrous odors distinct.†	22
...do	18.00	...do	...do	.0394	.0305	.0085	Dark yellow film and nitrous odors.‡	23
...do	13.20	...do	...do	.0985	.0020	.0135	Dark yellow film and strong nitrous odors.†	24
...do	24.0	.. do	...do	.4186	1.741	.031	Black film, with nitrogenous odors.‡	25
...do	49.6	...do	...do	.0788	.0035	.007	Darkening slight; strong nitrous odors.‡	26
...do	7.6	...do	...do	.1723	.005	.0185	Darkening slight; nitrous odors strong.‡	27
...do	14.80	...do	...do	.0640	.008	.0125	Darkening slight; nitrous odors strong.‡	28
...do	17.60	...do	...do	.0541	.003	.008	Darkening slight; nitrous odors strong.†	29
...do	21.40	...do	...do ...	.0886	.4395	.019	Darkening slight; nitrous odors strong.‡	30
...do	32.0	...do	...do	.1400	.4390	.012	Dark brown; nitrous odors strong.‡	31
Private.	5.8	...do	...do	.0900	.0025	.007	Darkening slight; nitrous odor marked. Good.	32
...do	3.80	.. do	...do	.3150	.0105	.016	Black islets and patches; nitrogenous odor.‡	33
Public ..	7.20	...do	...do	.0400	.0015	.0065	Darkening slight; nitrous odor strong.†	34
City	2.70	...do	None ...	.5300	.005	.057	Black waved concentric lines and patches difficult to dissipate; nitrogenous odor.‡	35

NEWPORT DRINKING

Number.	Collected.	Analyzed.	Transparency.	Color.	Odor.	Organic.	Inorganic.	Total solids.
	1881.	1881.						
36	Nov. 29	Dec. 2	Clear	None	None	23.0	52.00	75.0
37	Nov. 29	Dec. 2	do	do	do	24.0	77.00	101.0
38	Nov. 29	Dec. 2	do	Tinge of yellow	do	16.0	60.00	76.0
39	Nov. 29	Dec. 3	do	None	do	34.0	69.00	103.0
40	Nov. 29	Dec. 3	do	do	do	22.0	53.00	75.0
41	Nov. 29	Dec. 3	do	do	do	22.0	59.00	81.0
42	Nov. 29	Dec. 3	do	do	do	21.0	56.00	77.0
43	Dec. 1	Dec. 3	do	do	do	20.0	56.00	76.0
44	Dec. 1	Dec. 5	do	do	do	15.0	107.00	127.0
45	Dec. 1	Dec. 5	do	do	do	16.0	90.00	106.0
47	Dec. 2	Dec. 5	do	do	do	5.50	9.50	15.0
48	Dec. 2	Dec. 6	do	do	do	9.00	114.00	23.0
49	Dec. 2	Dec. 6	do	do	do	22.00	105.00	127.0
50	Dec. 2	Dec. 6	do	do	Faintly foul	20.00	69.00	89.0
51	Dec. 3	Dec. 6	do	do	None	31.00	124.00	155.0
52	Dec. 3	Dec. 7	do	do	do	15.00	50.00	65.0
53	Dec. 3	Dec. 7	do	do	do	20.00	42.00	62.0
54	Dec. 3	Dec. 7	do	do	do	17.00	46.00	63.0
55	Dec. 5	Dec. 8	do	do	do	30.00	94.00	124.0
56	Dec. 5	Dec. 8	do	do	do	18.00	21.00	39.0
57	Dec. 5	Dec. 8	do	do	do	9.00	90.00	99.0
58	Dec. 5	Dec. 8	do	do	do	19.00	63.00	82.0
59	Dec. 5	Dec. 8	do	do	do	11.00	31.00	42.0
60	Dec. 5	Dec. 9	do	do	do	40.00	84.00	124.0
61	Dec. 5	Dec. 9	do	do	do	24.00	47.00	71.0
62	Dec. 5	Dec. 9	do	do	do	37.00	62.00	99.0
63	Dec. 6	Dec. 9	do	do	do	25.50	59.50	76.0
64	Dec. 6	Dec. 10	do	do	do	25.00	37.00	62.0
65	Dec. 6	Dec. 10	Slightly hazy	do	do	7.00	5.50	12.5
66	Dec. 6	Dec. 10	Clear	do	do	15.00	23.00	38.0
67	Dec. 6	Dec. 10	do	do	do	21.00	53.00	74.9
68	Dec. 6	Dec. 10	do	do	do	4.00	6.00	10.0
70	Dec. 6	Dec. 10	Faintly hazy	Faint tinge yellow	do	3.50	8.50	12.0
71	Dec. 24	Dec. 27	Slightly hazy	Faintly yellow	None	4.00	10.00	14.0
72	Dec. 24	Dec. 27	do	do	do	4.00	10.50	14.5
	1882.	1882.						
74	Jan. 13	Jan. 13	Clear	None	do	15.00	38.00	53.0

NOTE.—Specimens 46 and 69 were

WATERS—Continued.

Kind of supply.	Chlorine.	Nitrous acid.	Nitric acid.	Oxygen required.	Free ammonia.	Albuminoid ammonia.	Characteristics.	Number.
Public ..	12.4	None ...	Present.	.0500	.006	.004	Darkening slight; nitrous odor strong. †	36
...do	14.4	...do	...do	.1100	.1235	.0115	Darkening slight; nitrous odor strong. ‡	37
...do	12.2	...do	...do	.3000	.6205	.0215	Evanescent burning with nitrous and nitrogenous odors. ‡	38
...do	14.8	...do	...do	.1400	.001	.010	Darkening slight; nitrous odor strong. †	39
...do	13.2	...do	...do	.1000	.003	.008	Darkening slight; nitrous odor strong. †	40
...do	18.0	...do	...do	.1100	.001	.010	Darkening slight; nitrous odor strong. †	41
...do	12.20	...do	...do	.2600	.002	.024	Darkening slight; nitrous odor strong. †	42
...do	20.0	...do	...do	.0500	.0025	.003	No darkening; nitrous odor strong. Excellent.	43
...do	23.2	...do	...do	.4000	4.185	.048	Black crust; strong nitrogenous odor. ‡	44
...do	17.0	...do	...do	.2850	.0155	.022	Dark brown crust with nitrous and nitrogenous odors. ‡	45
...do	2.20	...do	None ...	.3450	.013	.016	Black patches and rings, difficult to dissipate; slight nitrogenous odor. ‡	47
...do	4.80	...do	Present.	.1500	.0015	.006	Darkening slight; odor faint. Good.	48
...do	24.40	.2255	...do	.575	.004	.025	Brown crust, with nitrous and nitrogenous odors. ‡	49
...do	20.0	Trace...	...do	.145	1.321	.013	Darkening slight; strong nitrous odor. ‡	50
...do	29.2	None ...	...do	.5340	1.6450	.040	Brown crusts and nitrogenous odors. ‡	51
...do	11.6	...do	...do	.2350	.0105	.008	Darkening slight; odor (nitrous) marked. †	52
...do	9.2	...do	...do	.1250	.006	.011	Darkening slight; nitrous odor strong. †	53
...do	12.0	...do	...do	.3600	.0025	.021	Darkening considerable, but fugitive nitrous odor marked. ‡	54
...do	43.20	...do	...do	.1050	.0115	.0085	Darkening slight; nitrous odor strong. ‡	55
...do	5.60	...do	...do	.0900	.012	.0085	Darkening slight; nitrous odor marked. †	56
...do	22.40	.0360	...do	.2000	.0780	.0135	Darkening slight; nitrous odor distinct. ‡	57
...do	11.20	None ...	...do	.0500	.0035	.0105	Darkening slight; nitrous odor marked. †	58
...do	8.80	...do	...do	.0500	.0035	.0035	Darkening and nitrous odor slight. Good.	59
...do	35.40	Trace...	...do	.2800	.4400	.0225	Brown crusts and strong nitrous odor. ‡	60
...do	12.0	None ...	...do	.0900	.0045	.0055	Darkening slight; nitrous odor strong. Permissible.	61
...do	16.4	...do	...do	.0700	.0045	.0080	Darkening slight; nitrous odor strong. Permissible.	62
...do	13.0	...do	...do ...	.0800	.0280	.0045	Darkening slight; nitrous odor strong. ‡	63
...do	11.20	...do	...do	.0750	.0015	.0045	Darkening slight; nitrous odor strong. Good.	64
...do	00.52	...do	...do	.7300	.0055	.0520	Black lines and patches, nitrogenous fumes and odor. ‡	65
...do	7.20	...do	...do	.0300	.0020	.0065	Darkening slight; nitrous odor strong. Good.	66
...do	12.40	...do	...do	.1500	.0020	.0095	Darkening slight; nitrous odor strong. †	67
...do	00.52	...do	Trace...	.2500	.0070	.0170	Black lines and patches, and odor slight. ‡	68
City	2.70	...do	Trace only.	.7900	.0115	.0550	Black islets, with nitrogenous fumes and odor. ‡	70
City	2.60	None	None ...	.8800	.0050	.0610	Black islets and nitrogenous fumes. ‡	71
...do	2.60	...do	...do	.7800	.0100	.0630	Black islets and nitrogenous fumes. ‡	72
Private.	4.00	...do	Present.	.1300	.004	.014	Darkening slight; nitrous odor marked. †	74

lost by breakage in transportation.

ANALYSES OF CITY (EASTON'S POND) WATER, NEWPORT, R. I.

Numbers.	Collected.	Analyzed.	Residues.											
			Transparency.			Color.			Odor.			Organic.		
			Res.	Pond.	Pipes.	Res.	Pond.	Pipes.	Res.	Pond.	Pipes.	Res.	Pond.	Pipes.
	1881.	1881.												
5	Nov. 9	Nov. 11	.....	.....	Slightly hazy.	.....	.....	Faintly yellow	.....	.....	None.	.....	.....	7.0
35	Nov. 29	Dec. 2	.....	.....	....do	.....	.....	....do	.....	.....	..do ...	.....	.....	5.5
70	Dec. 6	Dec. 10	.....	.....	....do	.....	.....	....do	.....	.....	..do ...	.....	.....	3.5
71, 72	Dec. 24	Dec. 27	Slightly hazy.	Slightly hazy.	....	Faint yellow.	Faintly yellow	.....	None.	None.	.....	4.0	4.0	
	1882.	1882.												
100, 101, 102	March 20	March 23	Clear	in	all.	Faint	yellow	tinge.	No od	or	present.	9.0	5.0	5.0
103, 104, 105	Apr. 5	Apr. 7	Faintly		hazy.	Tinge of	yellow.	Yellow.	None.	None.	.....	5.5	5.5	3.5
106, 107, 108	Apr. 27	Apr. 28	Slightly	hazy.	Clear.	Taint.	Taint.	Taint.	None.	None.	.....	5.0	7.0	5.0
109, 110, 111	May 12	May 15	Slightly		hazy.	None.	Slightly dark	None.	None.	None.	.....	2.0	4.5	3.0
112, 113, 114	June 1	June 14	Hazy.	Hazy.	Hazy.	Faint yellow.	Yellow.	None.	None.	None.	.....	7.0	7.0	7.0
115, 116, 117	June 21	June 26	....do	... do	....do	Yellowish.	Yellowish.	Yellowish.	None	or	faint.	7.0	7.0	7.0
118, 119, 120	Aug. 11?	Aug. 14	Somewhat		hazy.	Faint yellow.	Markedly	yellow.	Faint.	Distinct.		7.0	8.5	7.5

Analysis of city water, &c.—Continued.

Numbers.	Collected.	Analyzed.	Residues.																	
			Inorganic.			Total solids.			Chlorine.			Nitrous acid.			Nitric acid.			Oxygen required.		
			Res.	Pond.	Pipes.	Res.	Pond.	Pipes.	Res.	Pond.	Pipes.	Res.	Pond.	Pipes.	Res.	Pond.	Pipes.	Res.	Pond.	Pipes.
	1881.	1881.																		
5	Nov. 9	Nov. 11	.....	.....	8.0	.....	.....	15.0	.....	.....	2.7	.....	.....	None.	.....	.....	Trace.	.....	.....	.7042
35	Nov. 29	Dec. 2	.....	.....	6.0	.....	.....	11.5	.....	.....	2.7	.....	.....	..do ...	.....	.....	None.	.....	.....	.5300
70	Dec. 6	Dec. 10	.....	.....	8.5	.....	.....	12.0	.....	.....	2.7	.....	.....	..do ...	.....	.....	None?	.....	.....	.7900
71, 72	Dec. 24	Dec. 27	10.0	10.5	.....	14.0	14.5	.....	2.6	2.6	.....	None.	None.	.....	None.	None.	.....	.8800	.7800	.....
	1882.	1882.																		
100, 101, 102	March 20	March 23	5.0	8.0	8.0	14.0	13.0	13.0	1.6	1.6	1.6	..do ...	..do ...	None.	Some.	Trace.	(?)	.5850	.5350	.6750
103, 104, 105	Apr. 5	Apr. 7	8.5	9.5	9.0	14.0	15.0	12.5	1.7	1.7	1.8	..do ...	..do ...	..do ...	None or faint trace.			.4700	.5350	.4300
106, 107, 108	Apr. 27	Apr. 28	6.0	7.0	5.5	11.0	14.0	10.5	1.9	1.9	1.8	..do ...	..do ...	..do ...	None.	None.	None.	.4800	.5750	.4450
109, 110, 111	May 12	May 15	5.0	4.5	4.0	7.0	9.0	7.0	1.6	2.0	1.6	..do ...	..do ...	..do ...	None or faint trace.			.4500	.5700	.4100
112, 113, 114	June 1	June 14	5.0	6.0	7.0	12.0	13.0	14.0	1.8	1.7	1.8	..do ...	..do ...	..do ..	Trace.	Trace.	Trace.	.3650	.6650	.3400
115, 116, 117	June 21	June 26	5.0	5.5	5.0	12.0	12.5	12.0	2.0	2.0	1.9	..do ...	..do ...	..do ...	None.	None.	None.	.5400	.5650	.5300
118, 119, 120	Aug. 11?	Aug. 14	7.5	6.5	5.5	14.5	15.0	13.0	2.2	2.2	2.2	Trace.	..do ...	..do ..	Trace.	Trace.	Trace.	.7350	.8400	.9800

Analysis of city water—Continued.

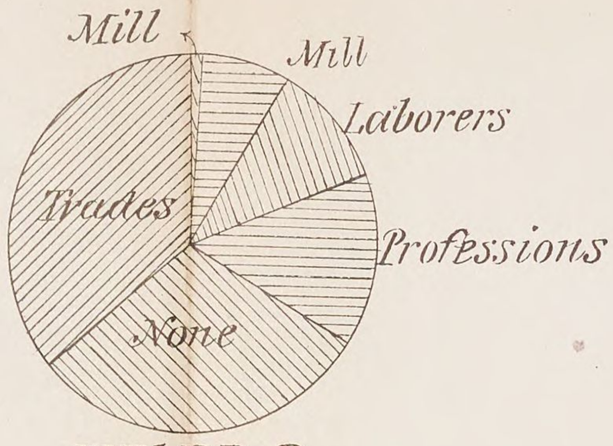
Numbers.	Collected.	Analyzed.	Ammonias. Free. Res.	Free. Pond.	Free. Pipes.	Albuminoid. Res.	Albuminoid. Pond.	Albuminoid. Pipes.	Characteristics.	Quality.	
	1881.	1881.									
5	Nov. 9	Nov. 11	.....	.....	.0100	.....	.....	.0680	Black patches difficult to dissipate; slight nitrogenous fumes	‡‡‡	
35	Nov. 29	Dec. 2	.....	.....	.0050	.....	.....	.0570	Black-waved concentric lines and patches difficult to dissipate; nitrogenous odor.	‡‡‡	
70	Dec. 6	Dec. 10	.....	.....	.0115	.....	.....	.0550	Black eyelets with nitrogenous fumes and odor. (Filtered.)	‡‡‡	
71, 72	Dec. 24	Dec. 27	.0050	.0100	.....	.0610	.0630	.....	Do	‡	
	1882.	1882.									
100, 101, 102	March 20	March 23	.0070	.0070	.0080	.0420	.0390	.0370	Black rings and eyelets with nitrogenous fumes and odor	‡‡‡	
103, 104, 105	Apr. 5	Apr. 7	.0035	.0055	.0080	.0325	.0350	.0255	Black eyelets and lines with peaty odors; no fumes	‡‡‡	105 permissible.
106, 107, 108	Apr. 27	Apr. 28	.0020	.0080	.0080	.0455	.0640	.0335	Black rings and patches with vegetable odor in all. Fumes in reservoir and pond.	‡‡‡	
109, 110, 111	May 12	May 15	.0020	.0080	.0070	.0450	.0580	.0320	Do	‡‡‡	
112, 113, 114	June 1	June 14	.0200	.0600	.0200	.0285	.0330	.0280	Black eyelets and rings, slowly dissipated with peaty odors and fumes.	‡‡‡	
115, 116, 117	June 21	June 26	.0360	.0310	.0130	.0730	.0840	.0650	Do	‡‡‡	
118, 119, 120	Aug. 11?	Aug. 14	.0080	.0050	.0050	.0830	.1050	.0960	Black residue slowly disappearing, with fumes in all.	‡‡‡	

*In the last column, those samples classed as "very suspicious or bad" are marked with a double dagger. No. 105, the only one considered permissible, is so written in full.

CITY OF NEWPORT
RHODE ISLAND

SCALE
0 600 1200 1800 3600 FEET

NARRAGANSETT BAY
NEWPORT HARBOR
ATLANTIC OCEAN
MIDDLETOWN
GOAT ISLAND
U.S. NAVAL STATION
BISHOP ROCK
CODDINGTONS POINT
OLD COLONY R.R.
LILY POND
ALMY'S POND
EASTON'S POND
1
2
3
4
5



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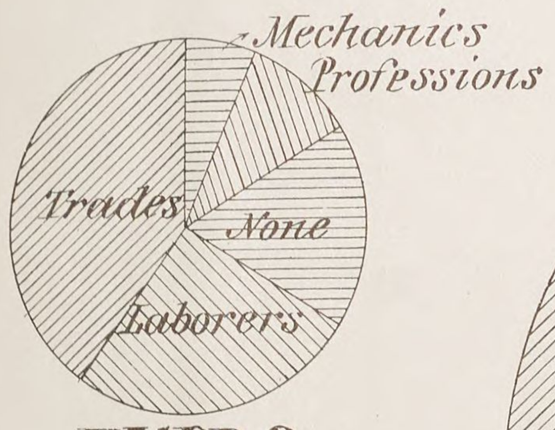
OCCUPATION.



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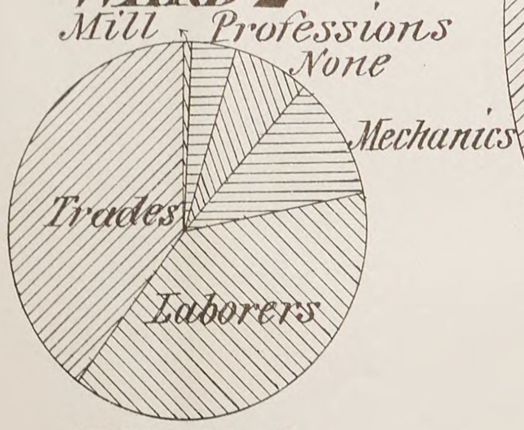

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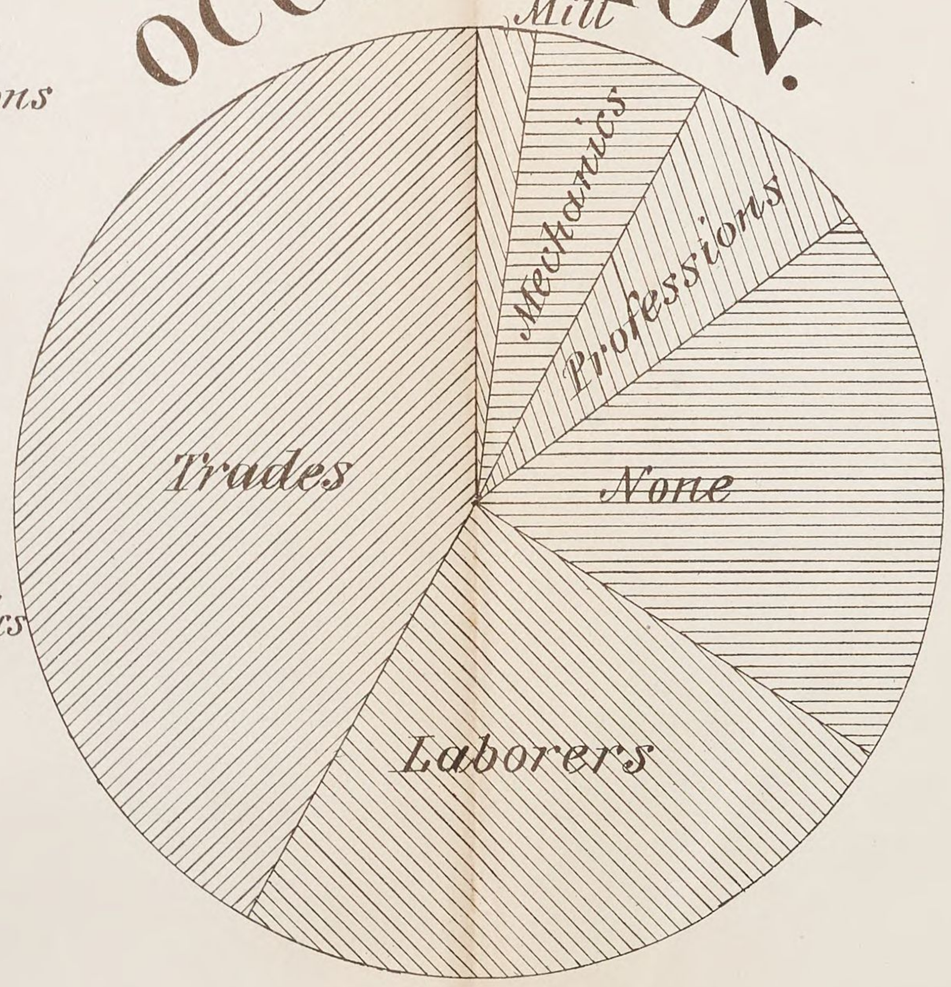

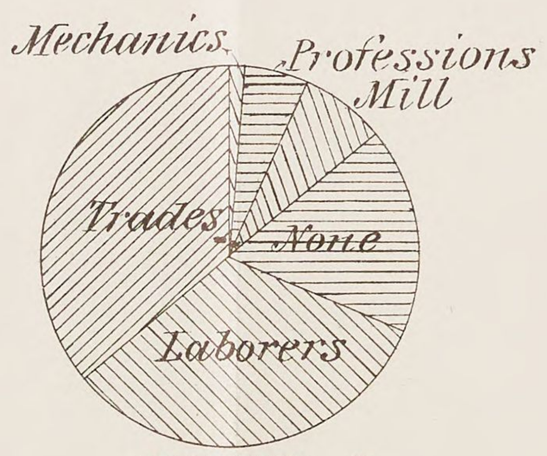

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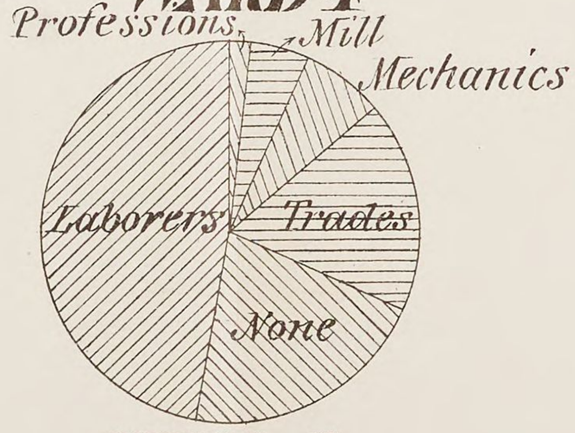
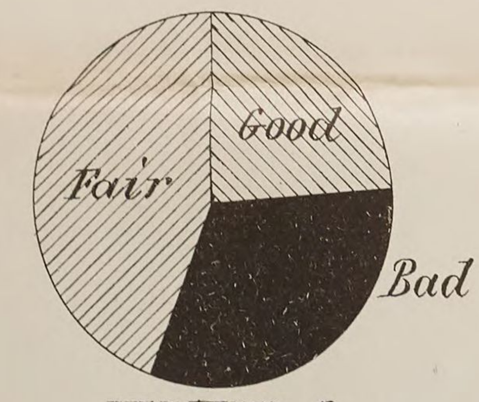


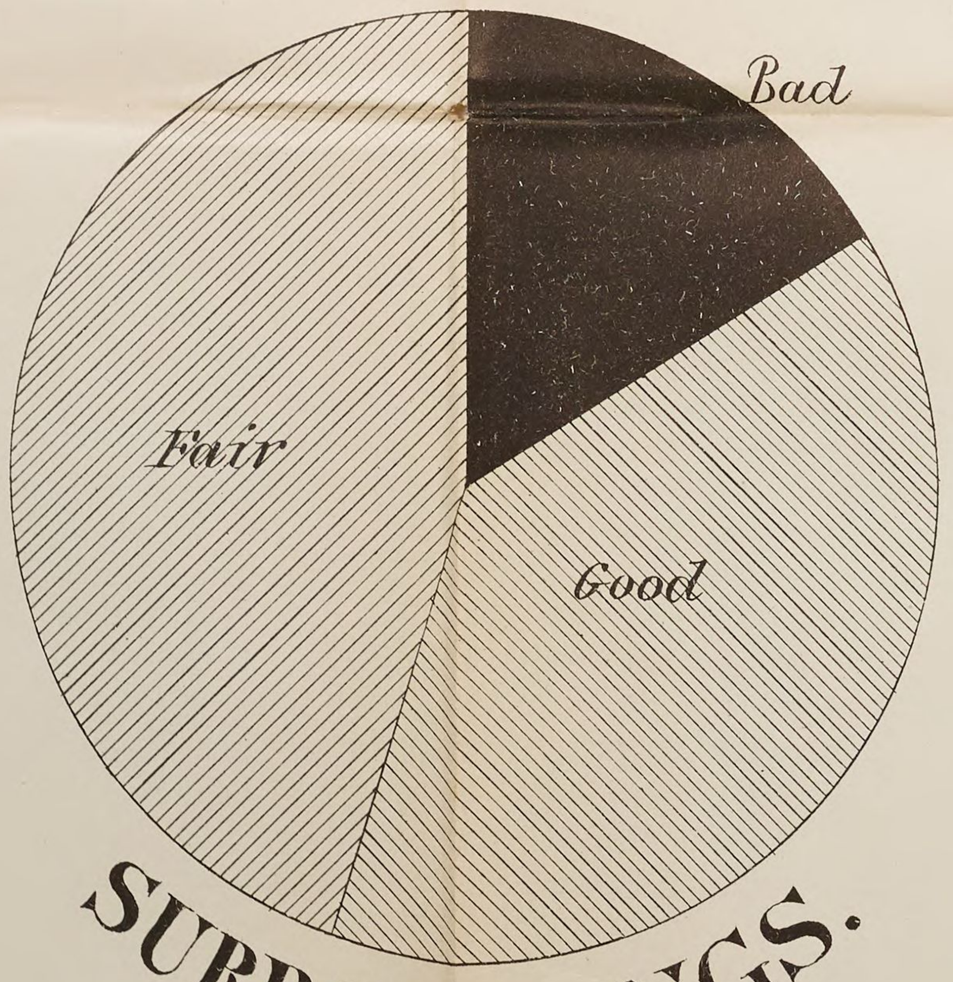
WARD 5

CITY OF NEWPORT



WARD 1

WARD 2



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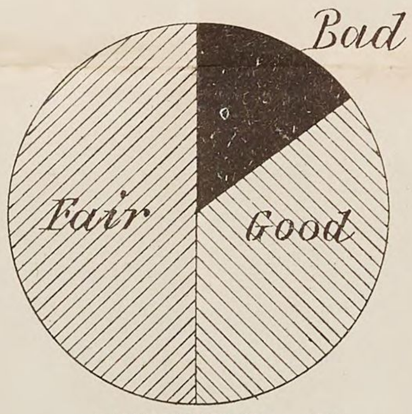
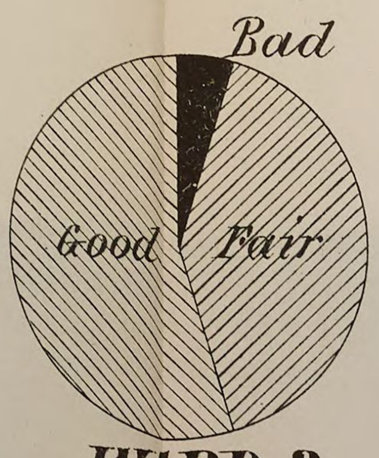


WARD 5

WARD 4



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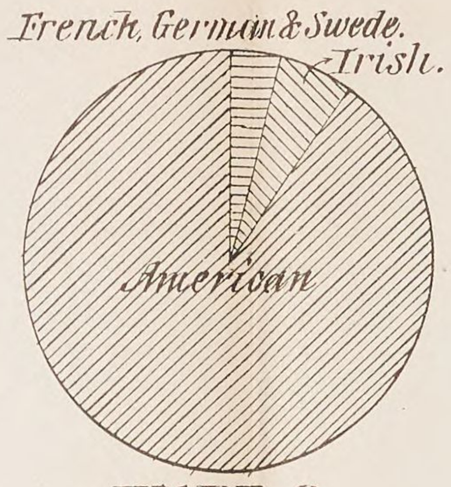

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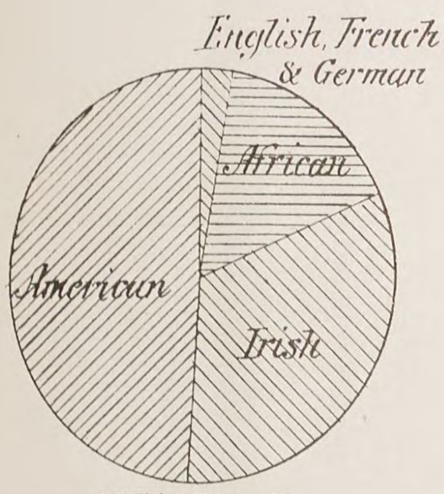
NATIONALITY



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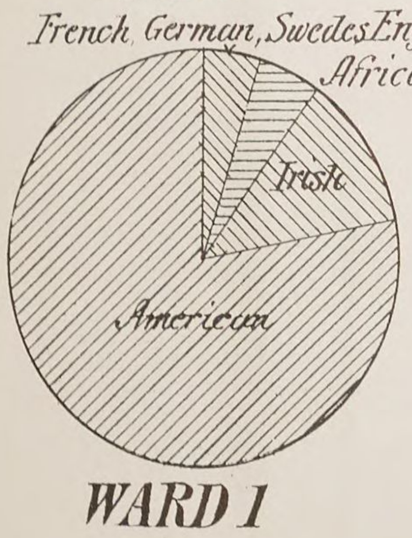

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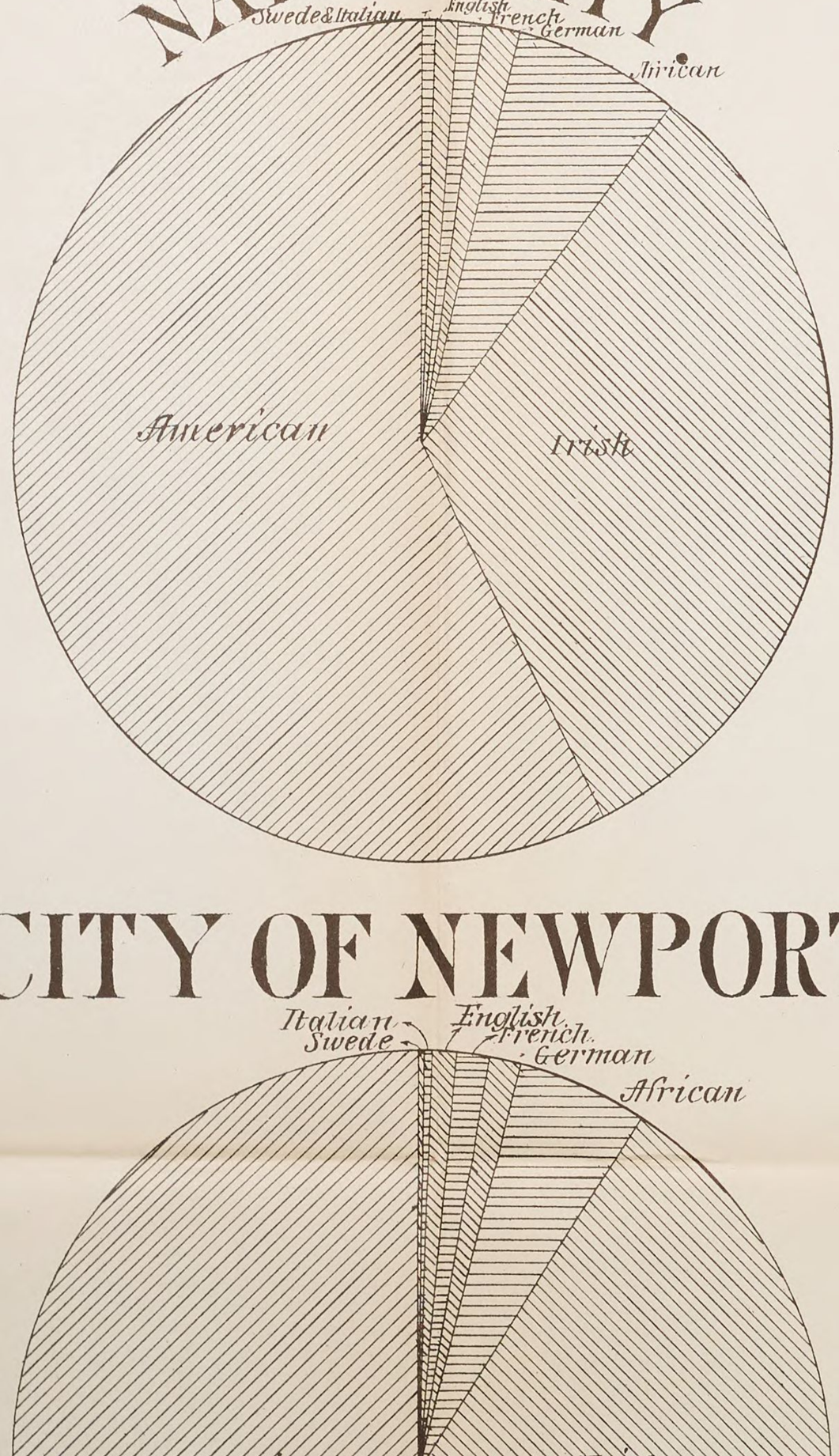

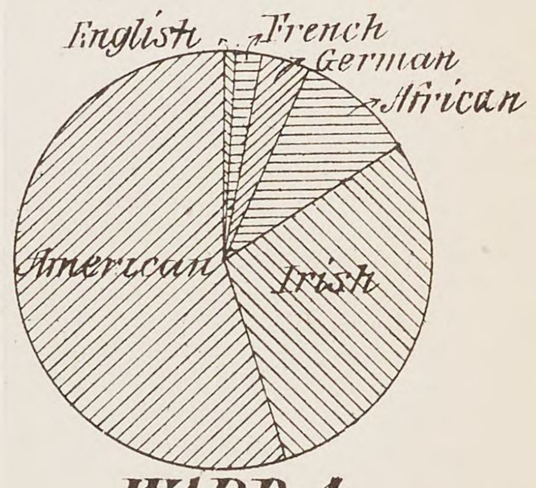

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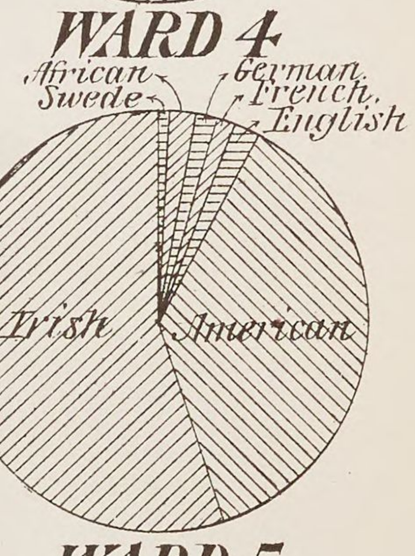
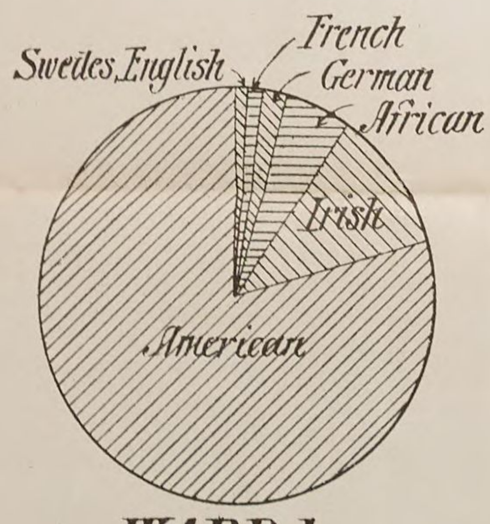


WARD 5

CITY OF NEWPORT



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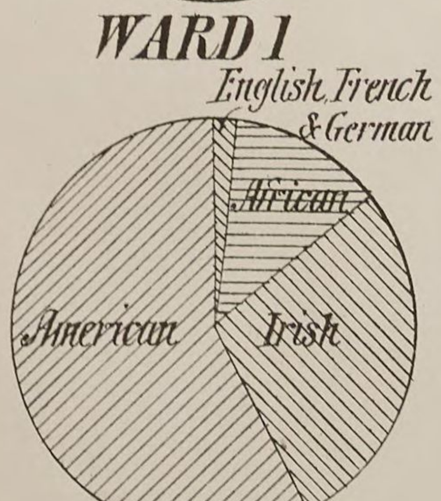

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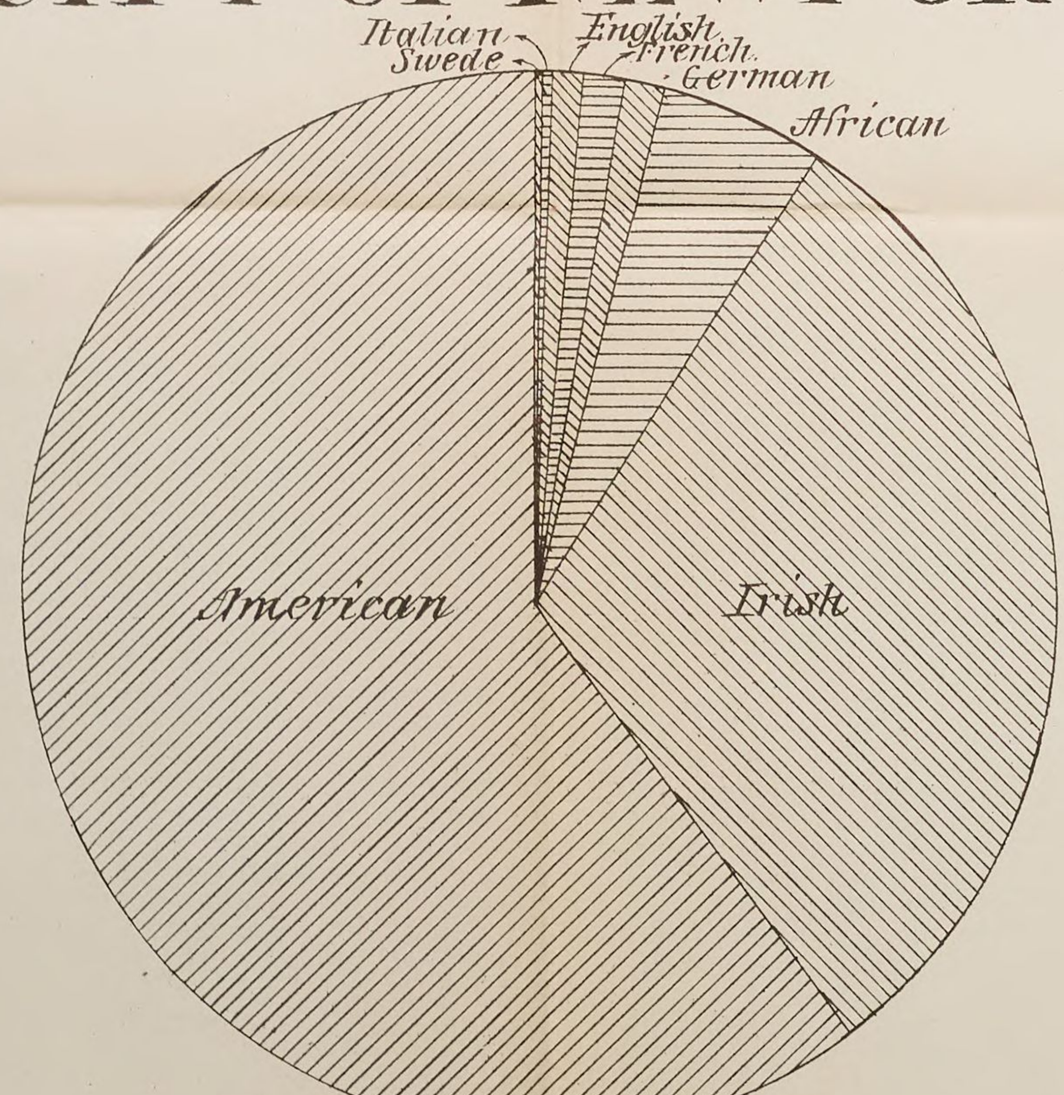

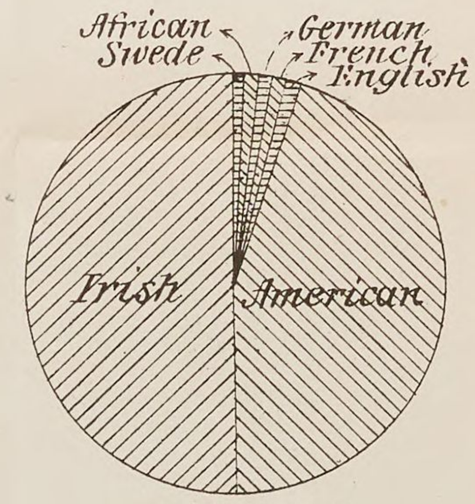

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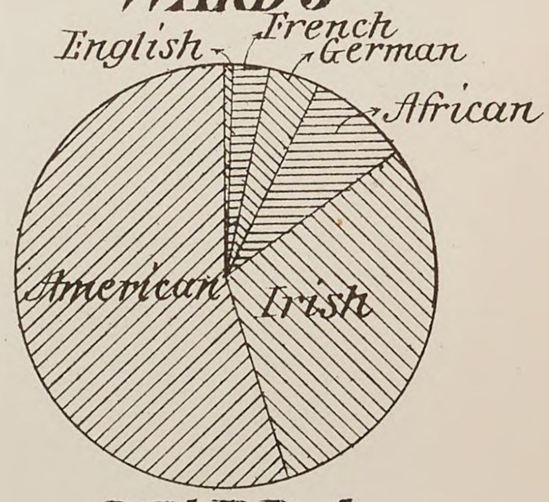
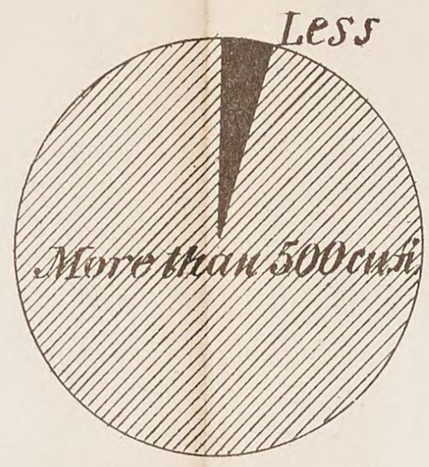


WARD 4

NUMBER

WARD 3

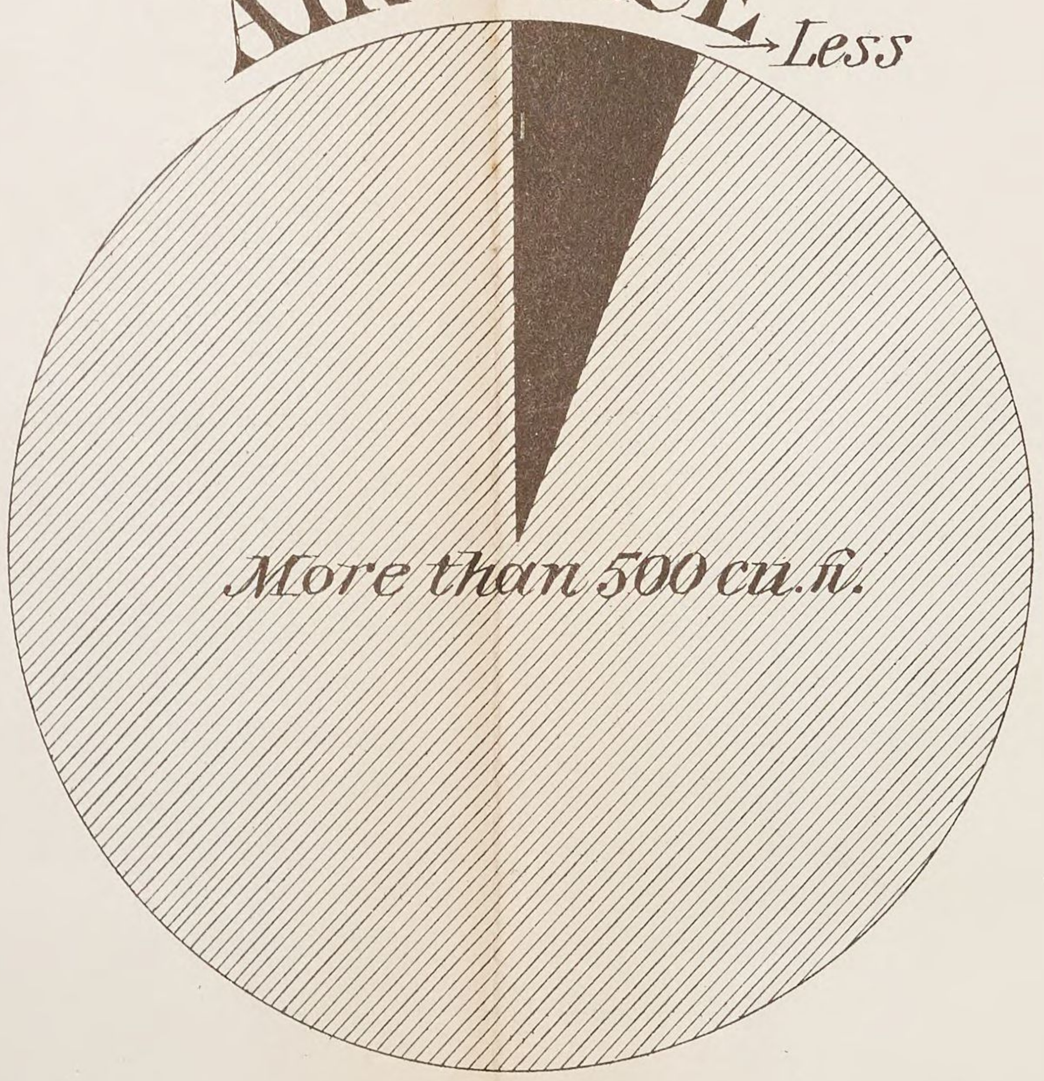


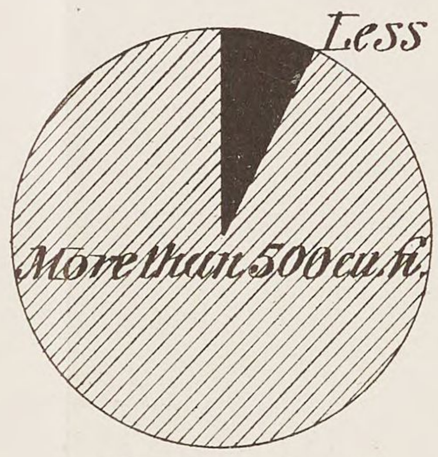
WARD 3

AIR SPACE

WARD 2

WARD 1





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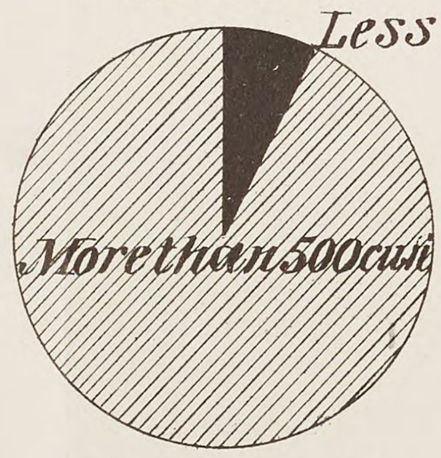
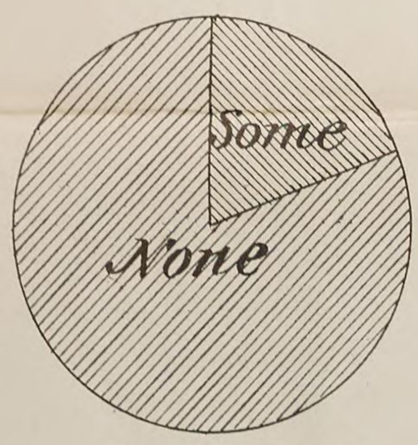


WARD 5

CITY OF NEWPORT



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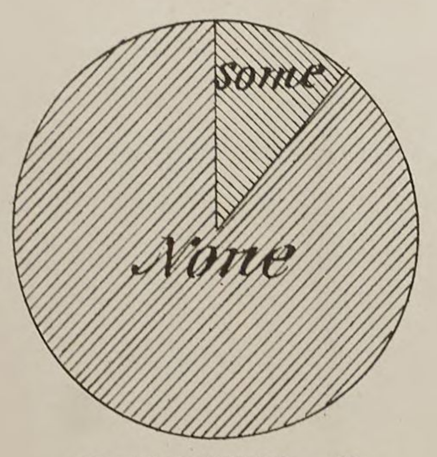

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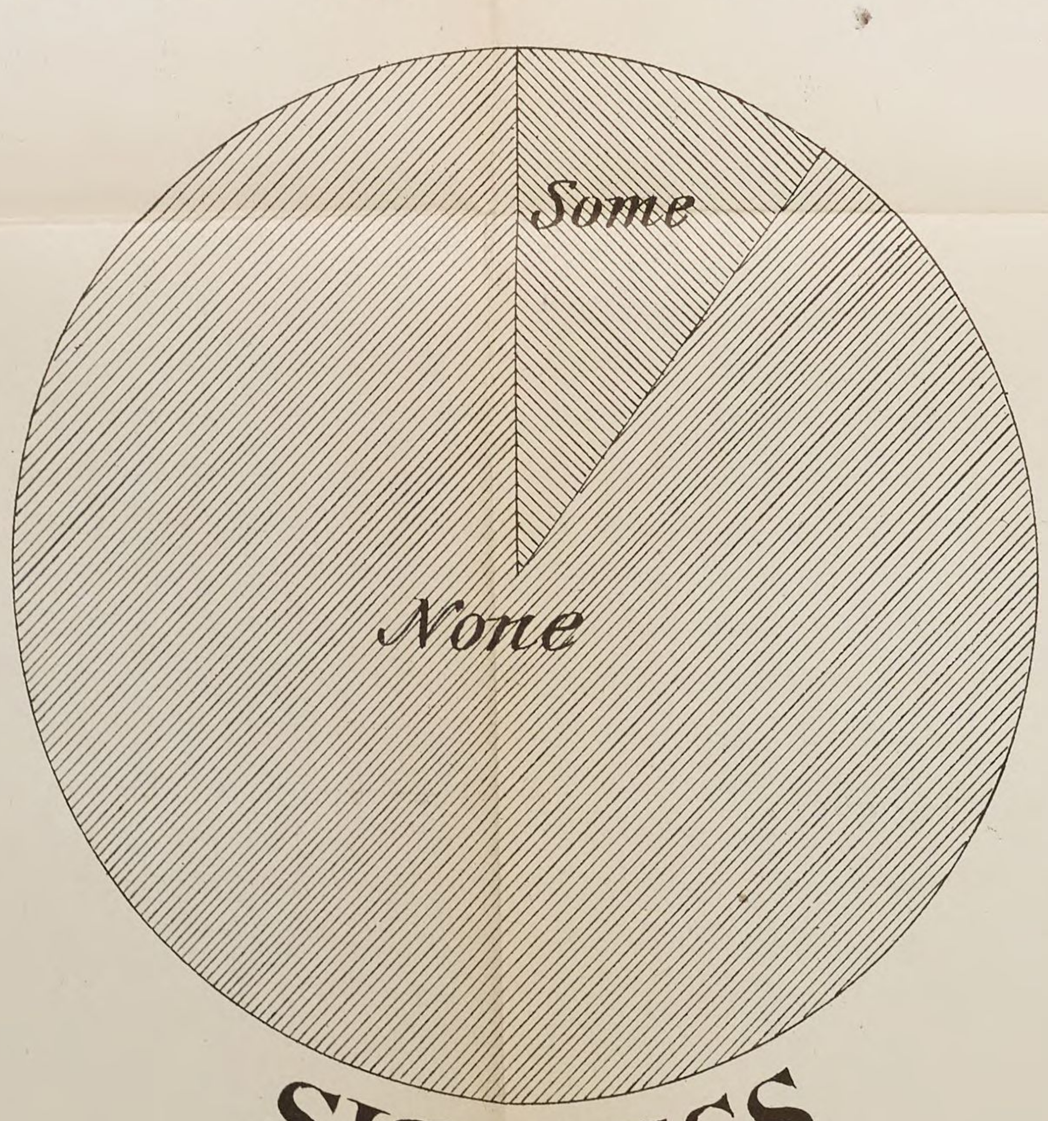
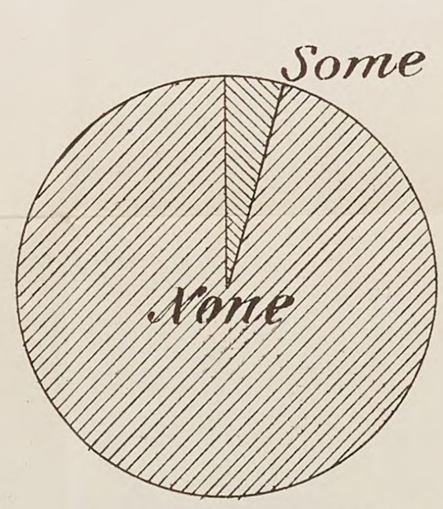


SICKNESS



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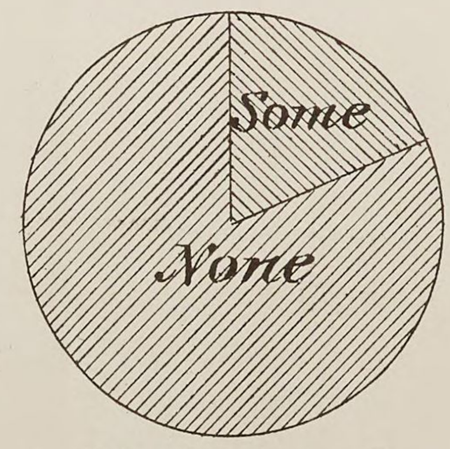

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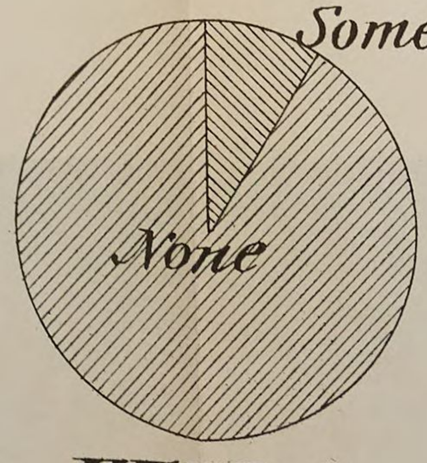
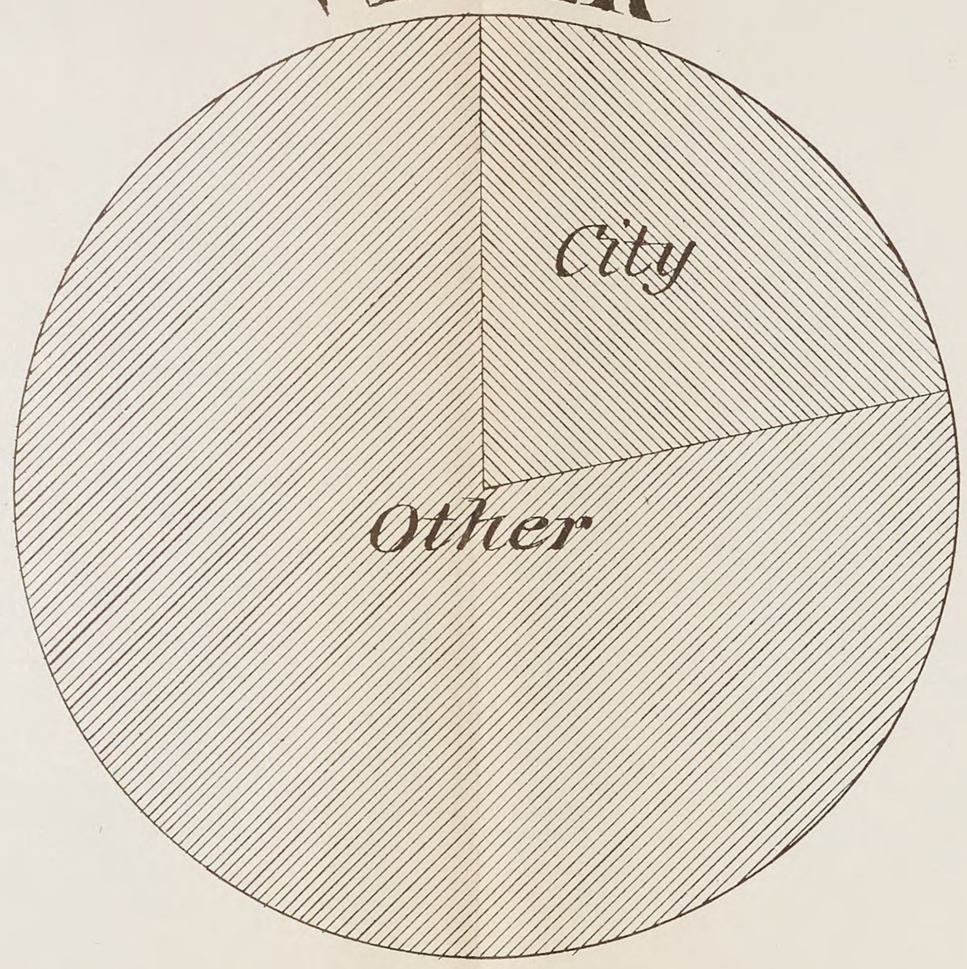


WARD 3

WARD 3

WATER



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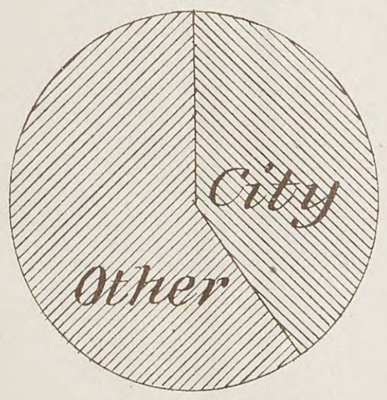

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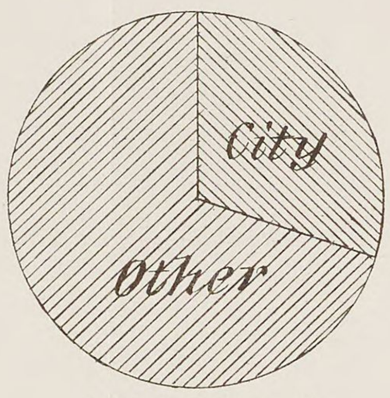

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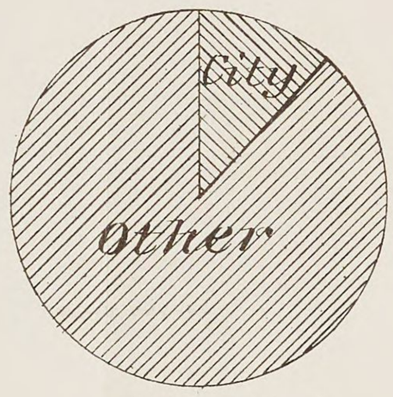
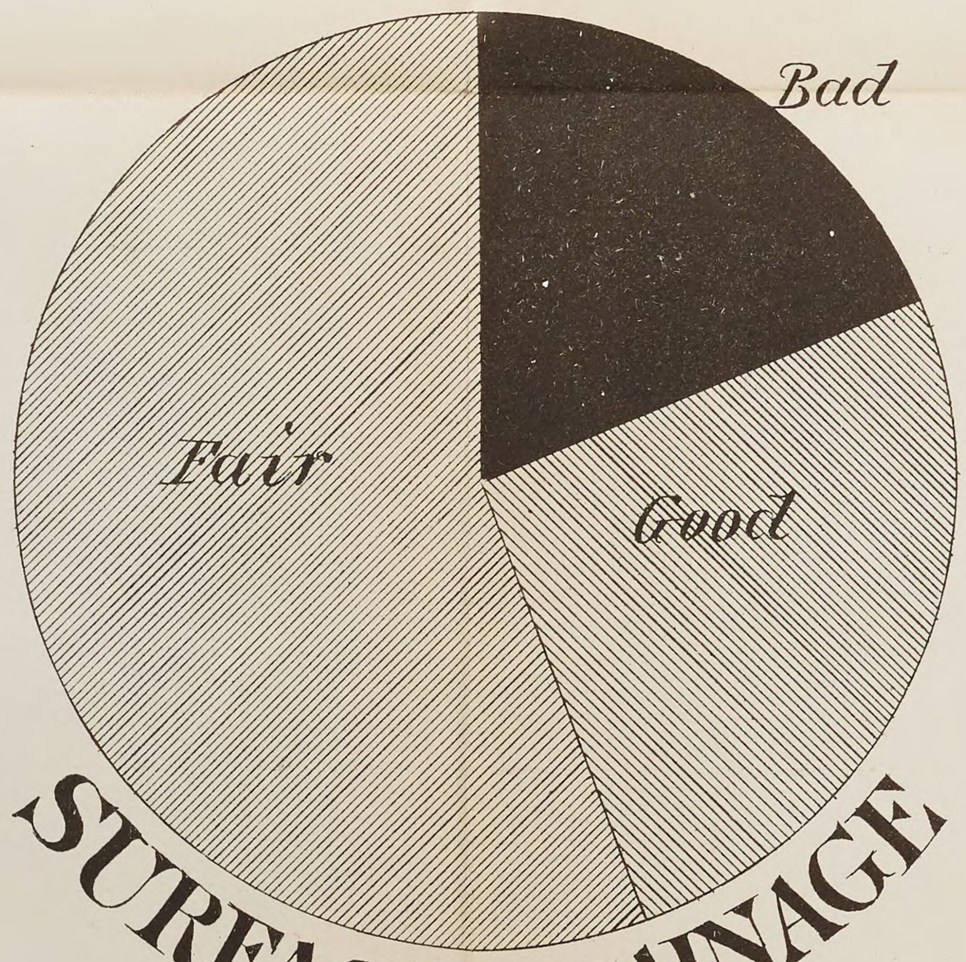
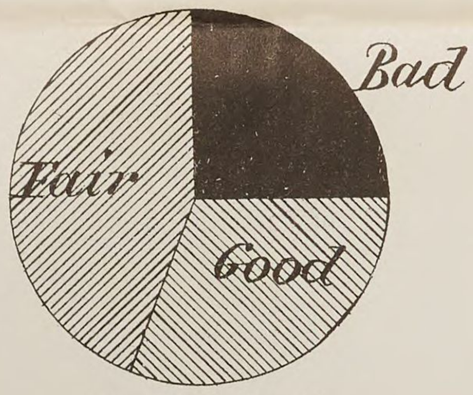


WARD 5

CITY OF NEWPORT



SURFACE DRAINAGE



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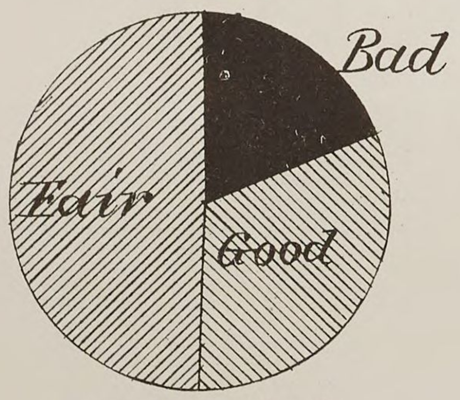

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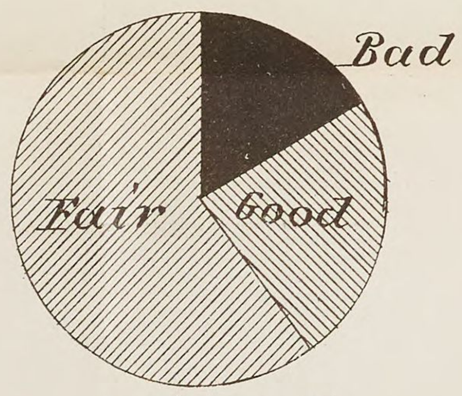

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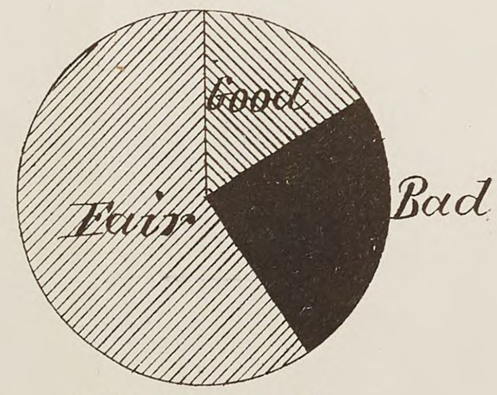
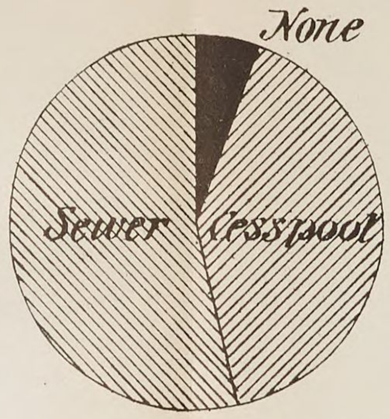


WARD 4

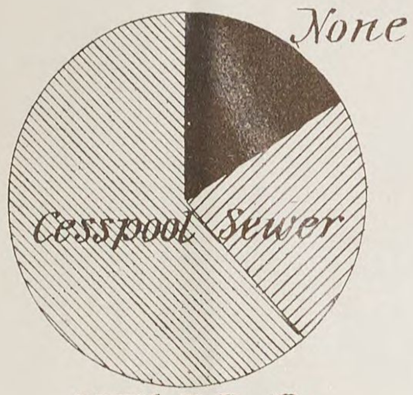
WARD 3

MENARD'S
CILA ÖIL



WARD 3

SEWERAGE



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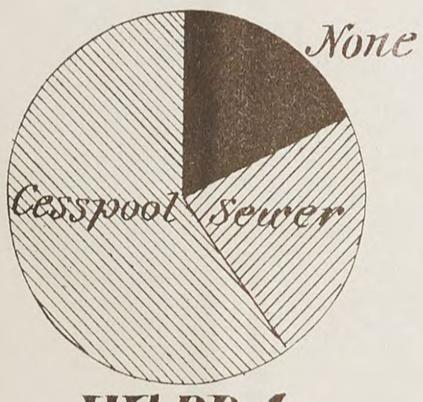
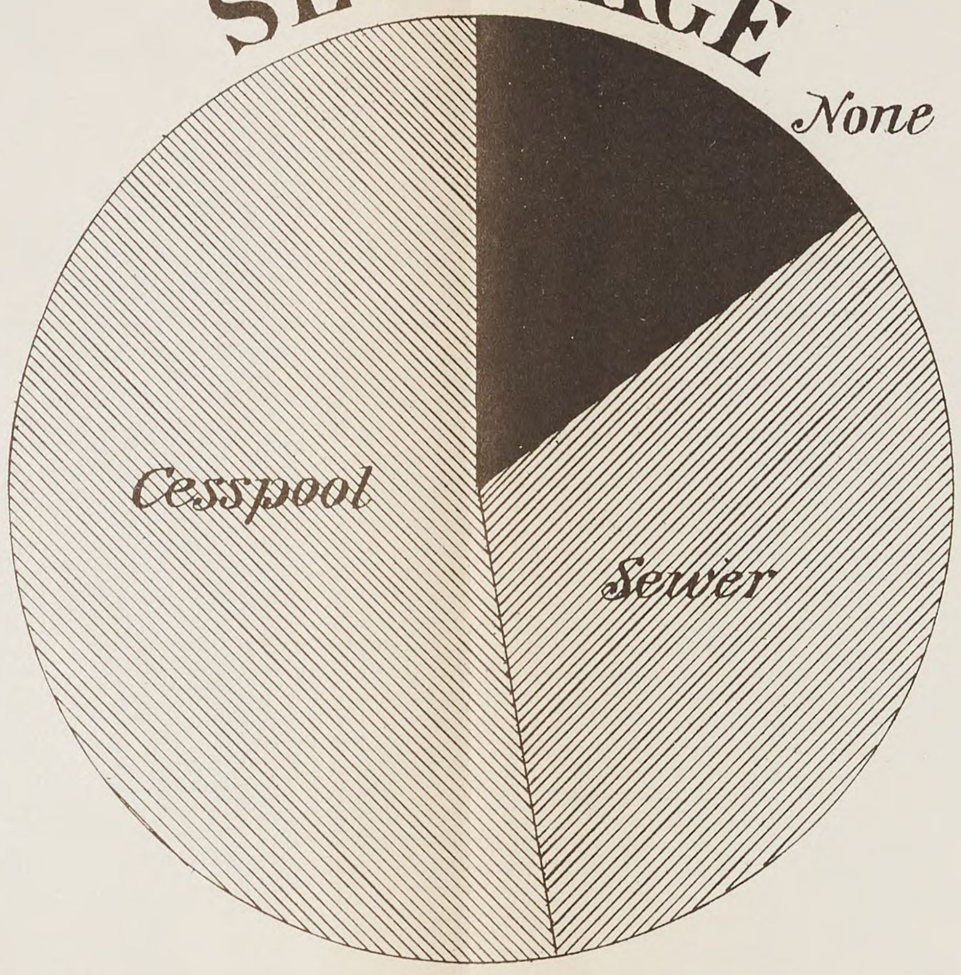
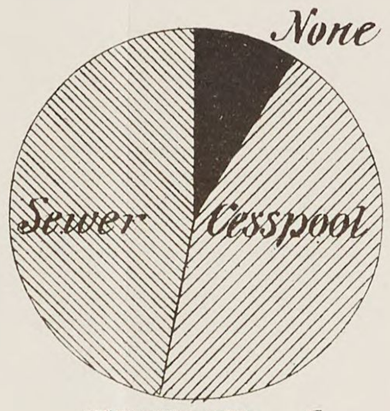


WARD 1





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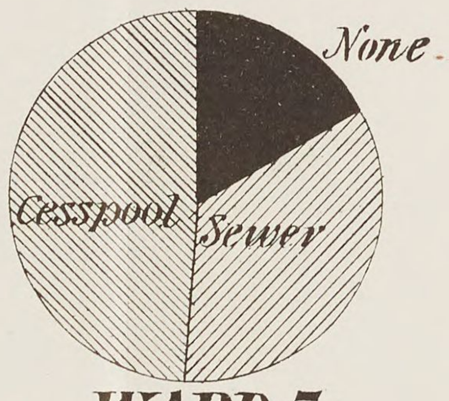
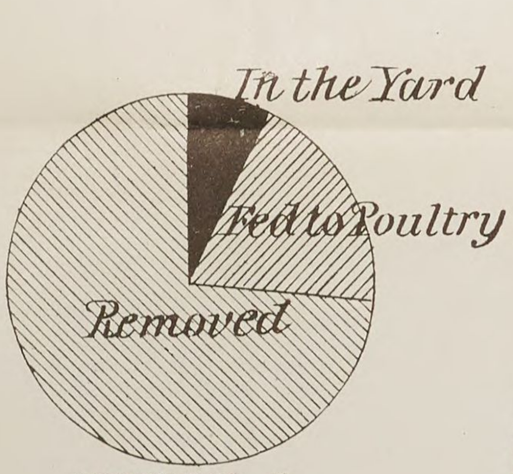


WARD 5

CITY OF NEWPORT



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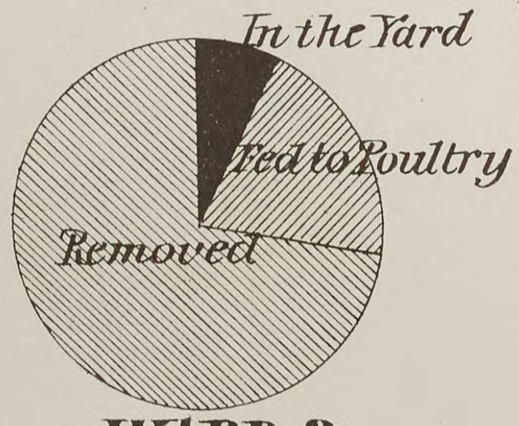

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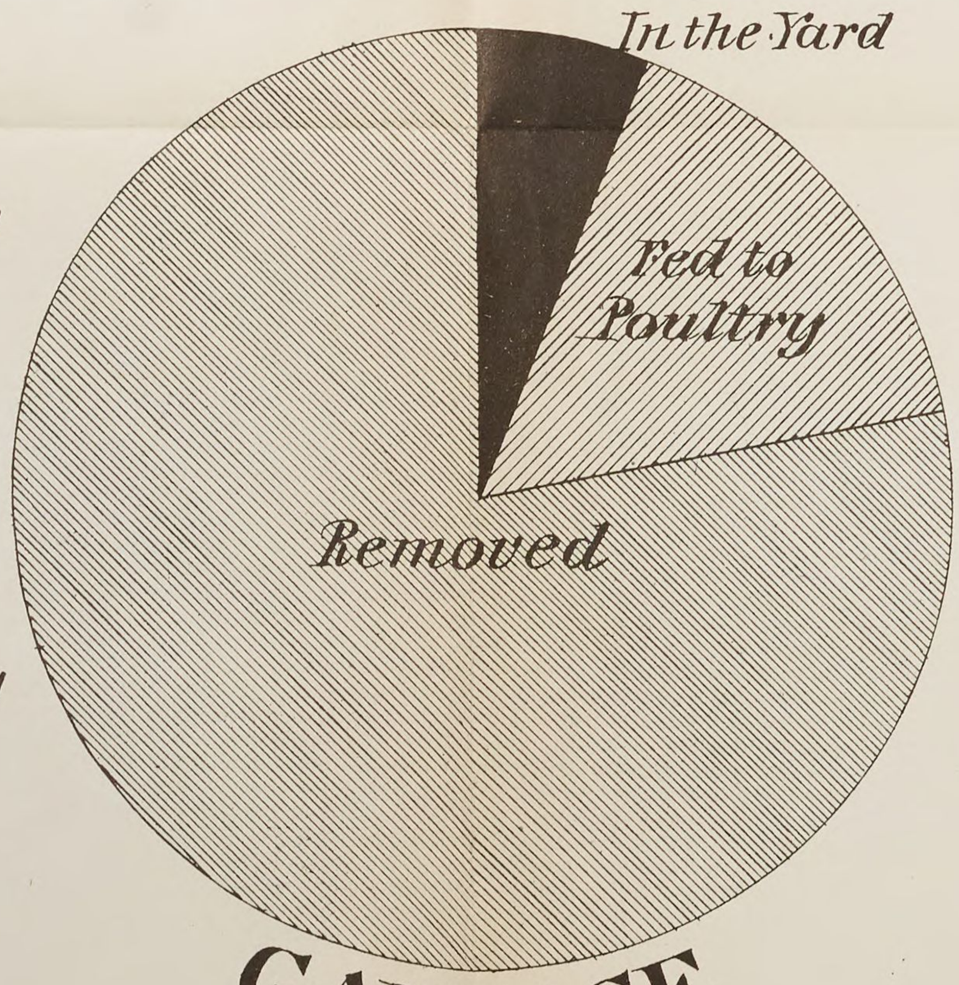
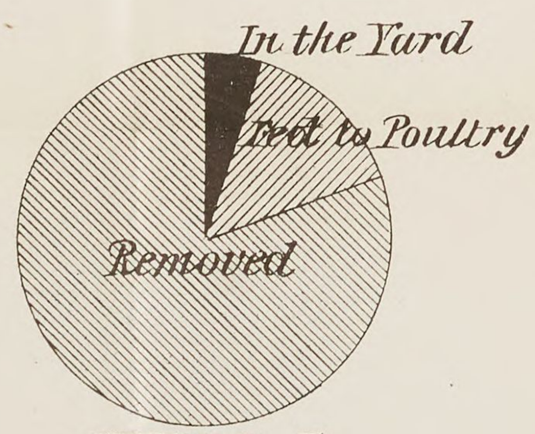


GARBAGE



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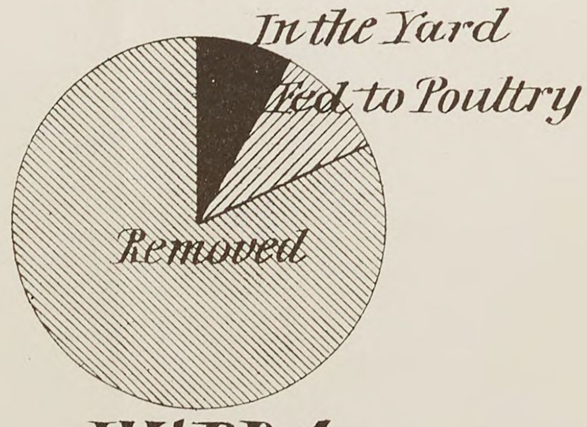

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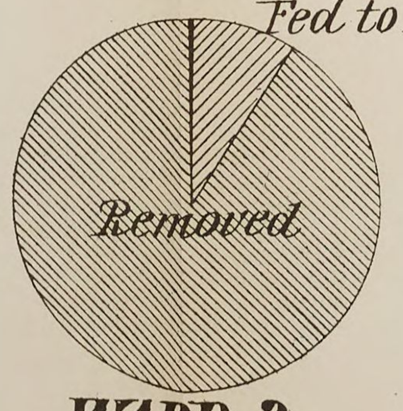

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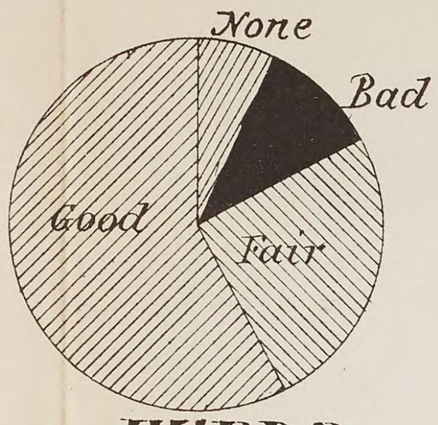
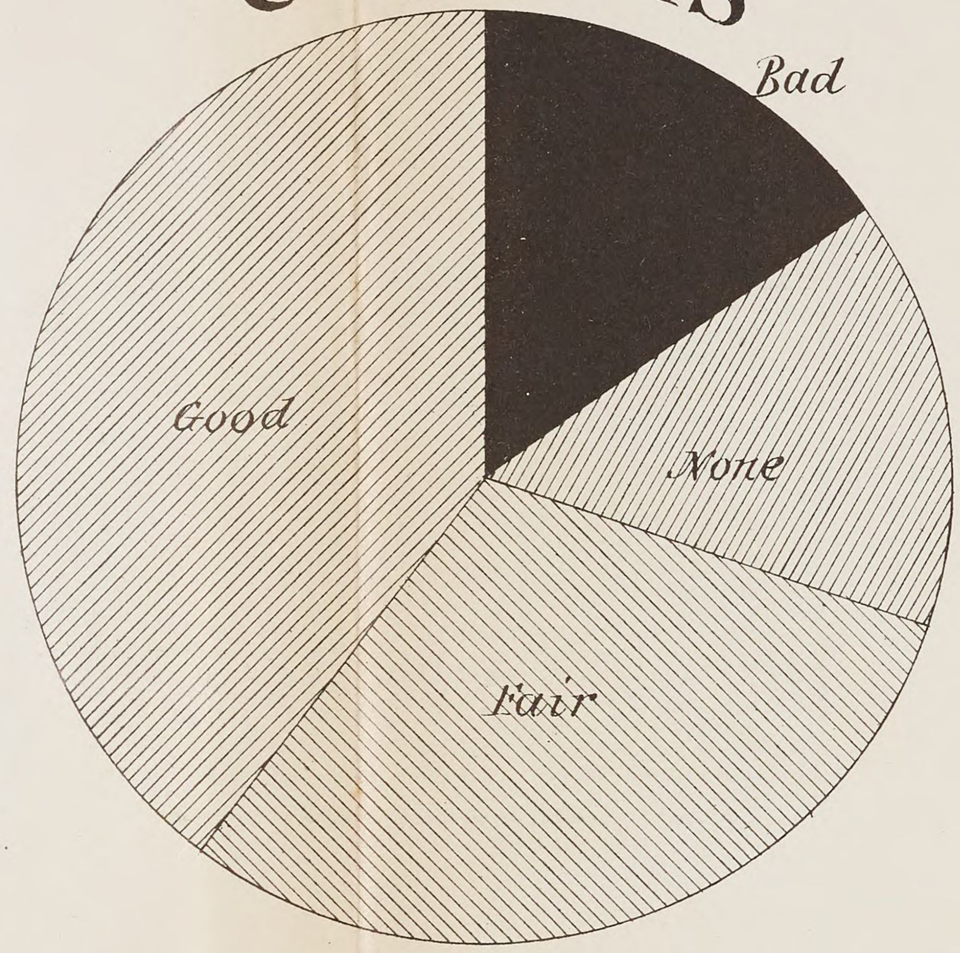


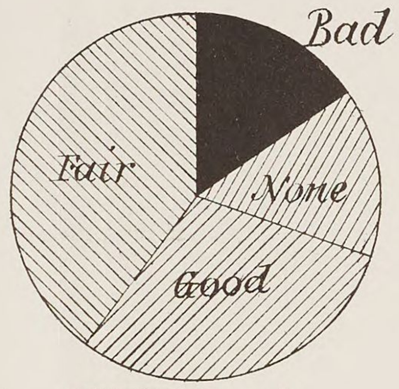
WARD 3

CELLARS

WARD 2

WARD 1



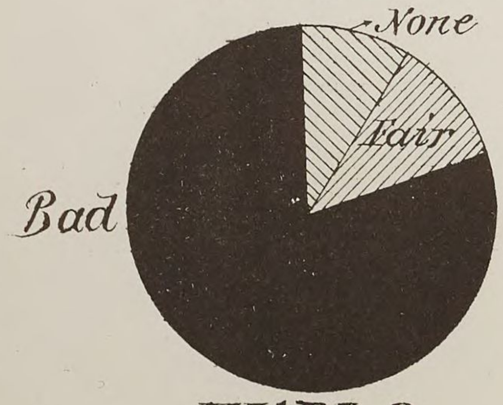


WARD 4

WARD 5

CITY OF NEWPORT

WARD 1



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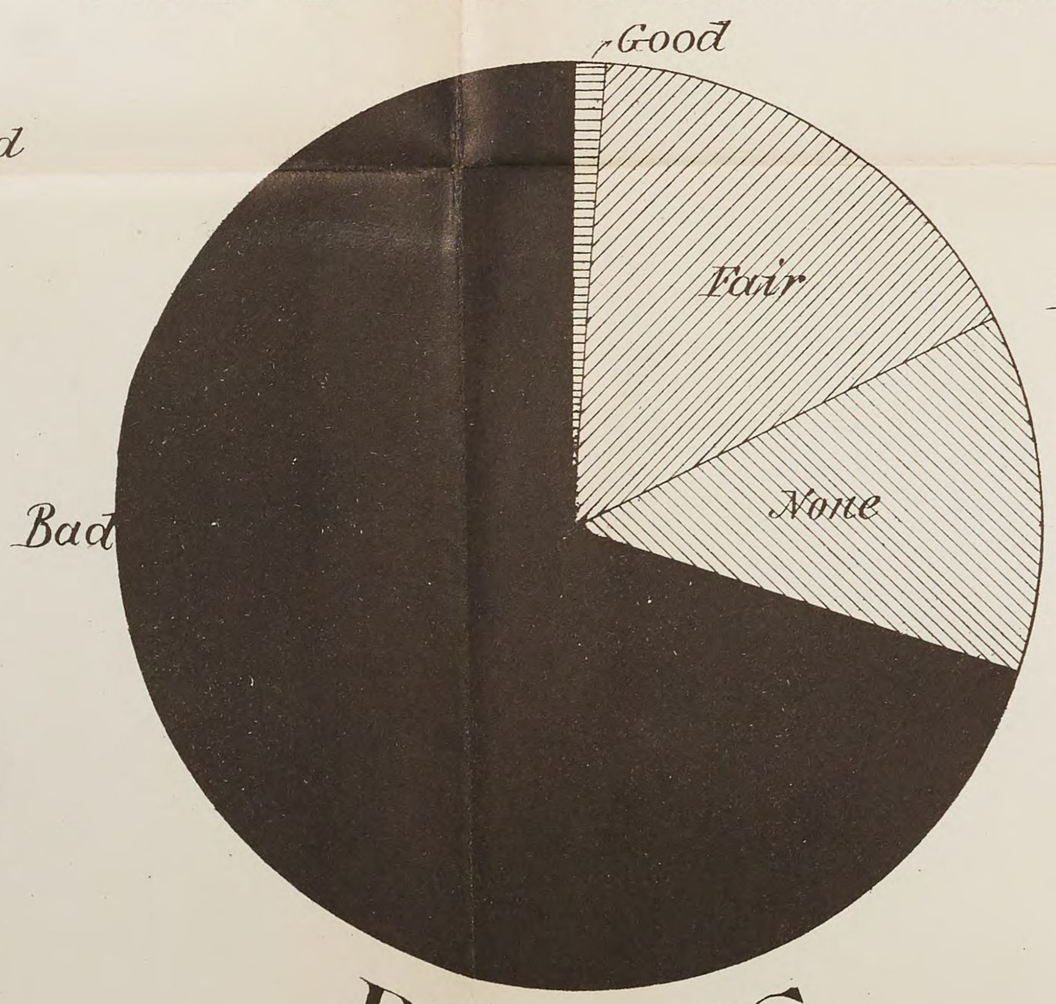

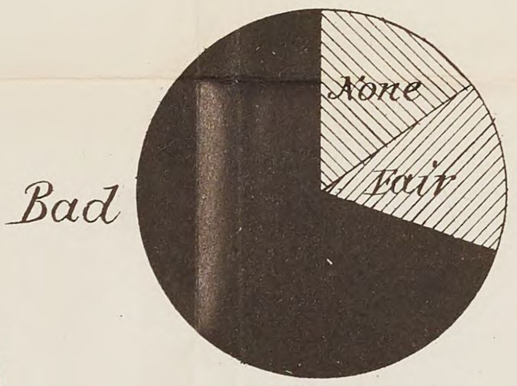

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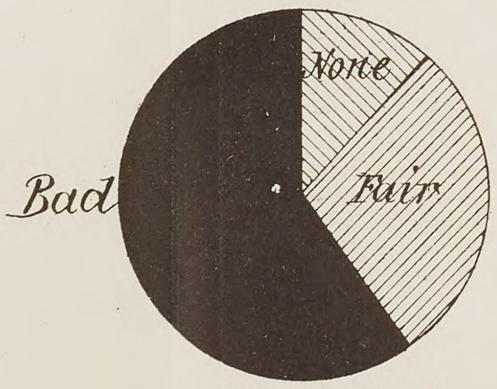

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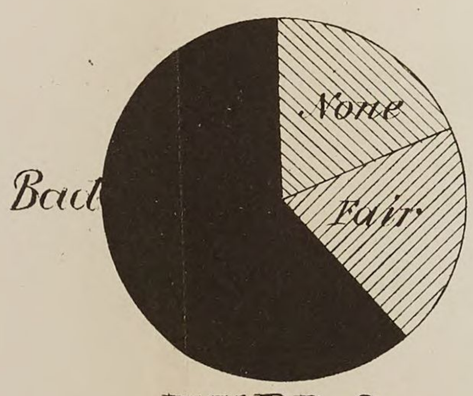
PRIVIES



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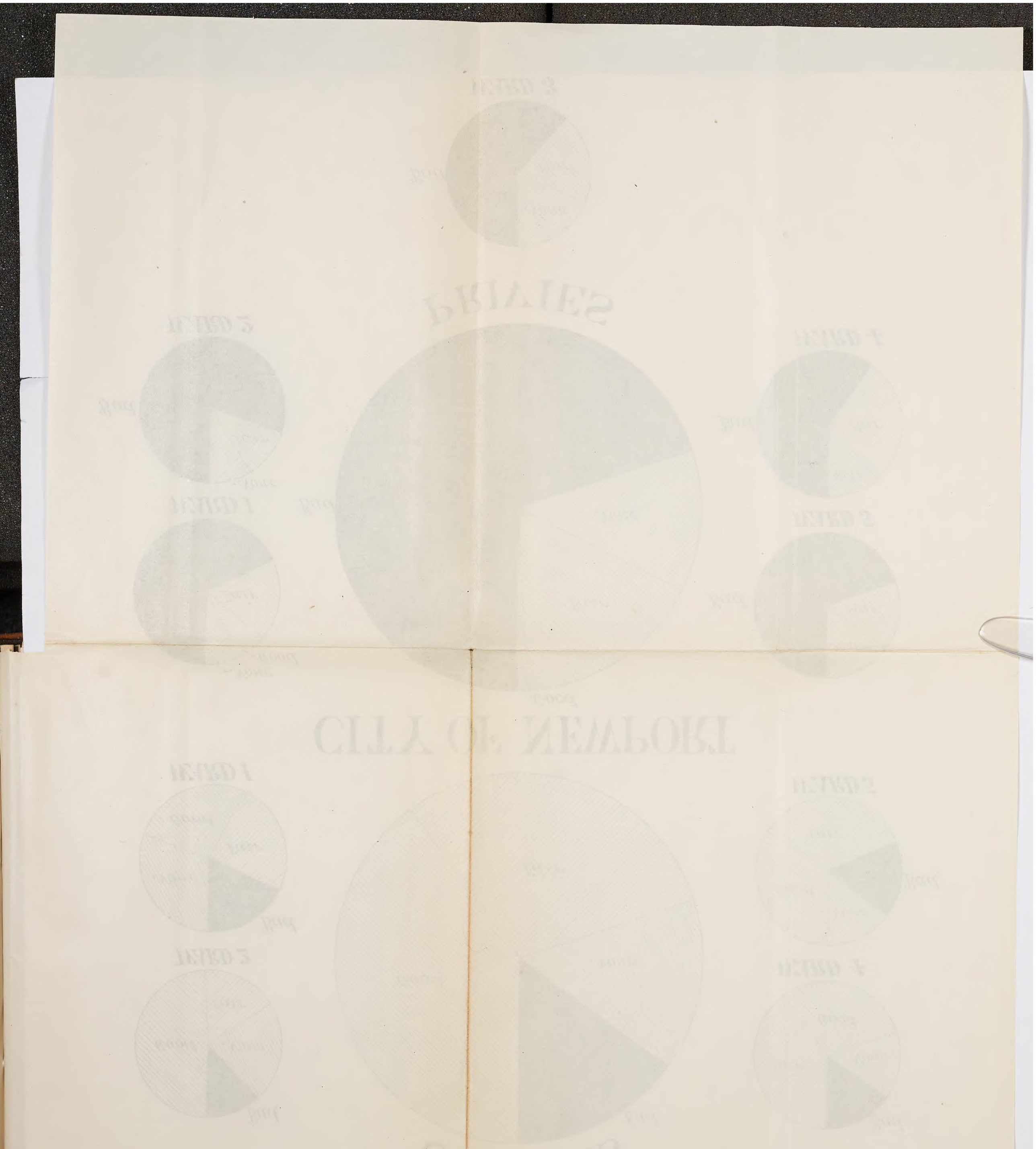

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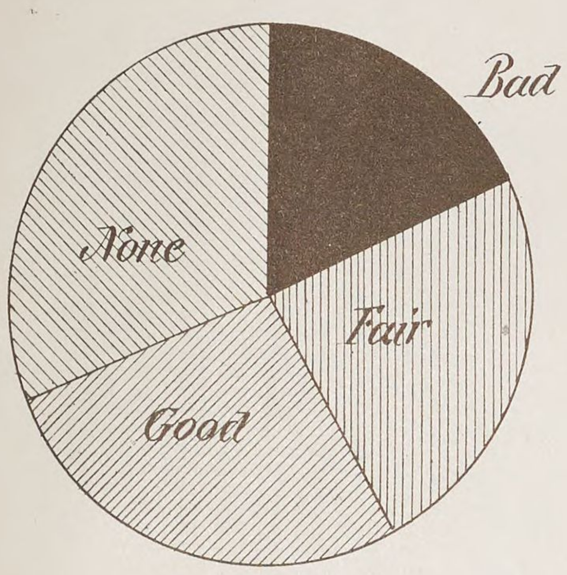
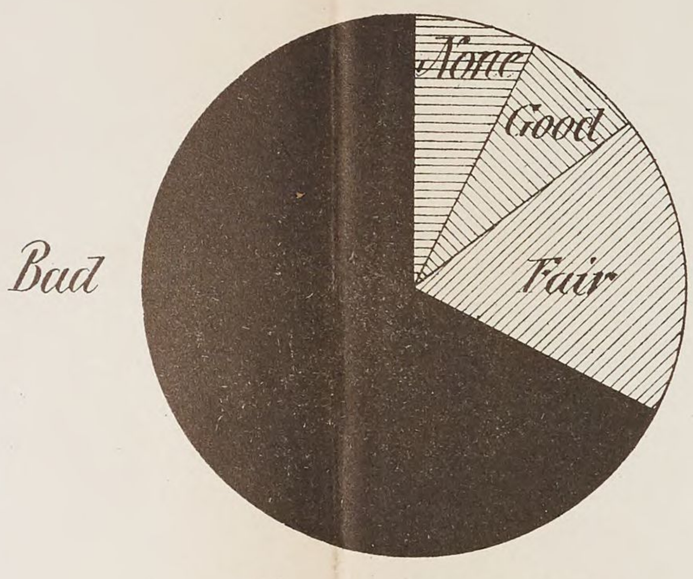
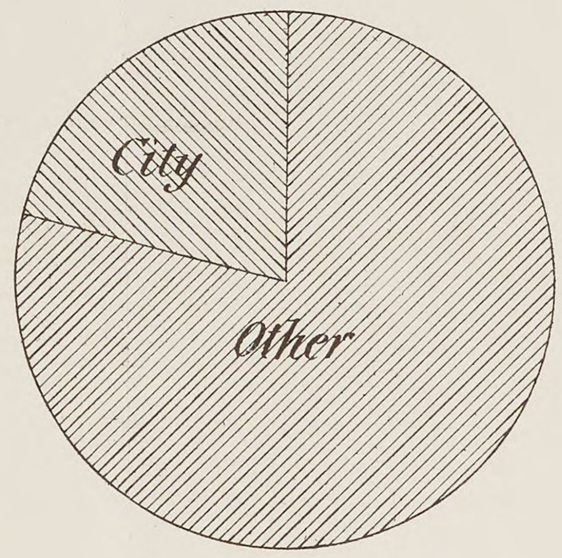


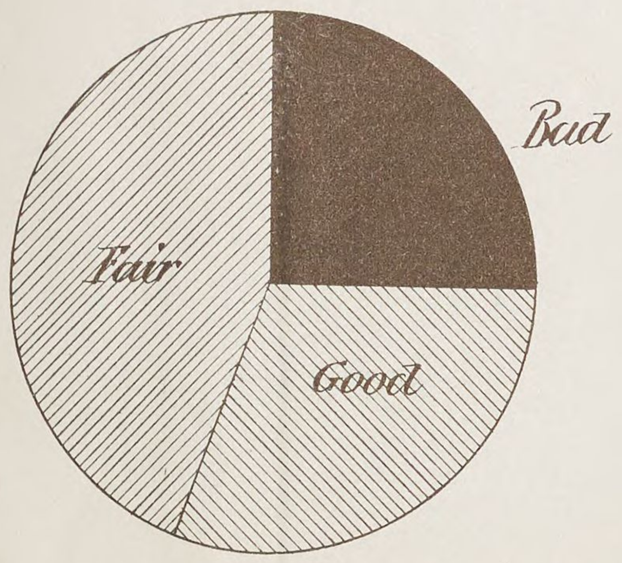
CELLARS



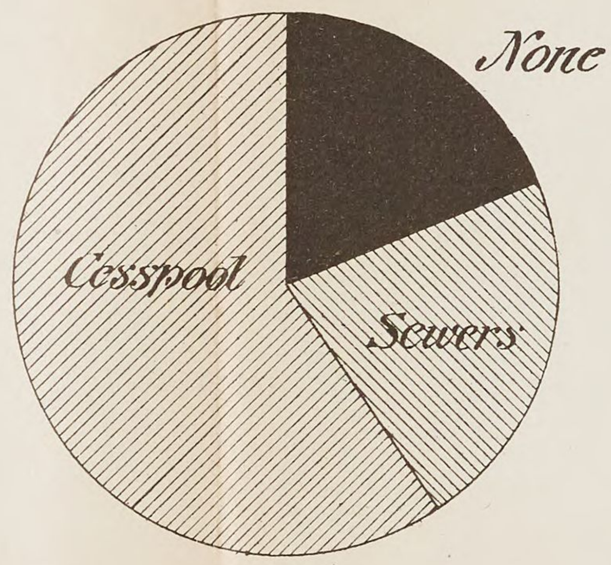
PRIVIES



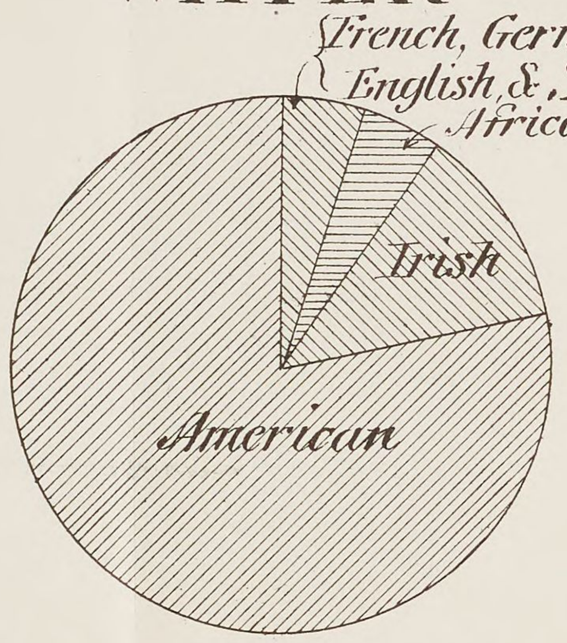
WATER



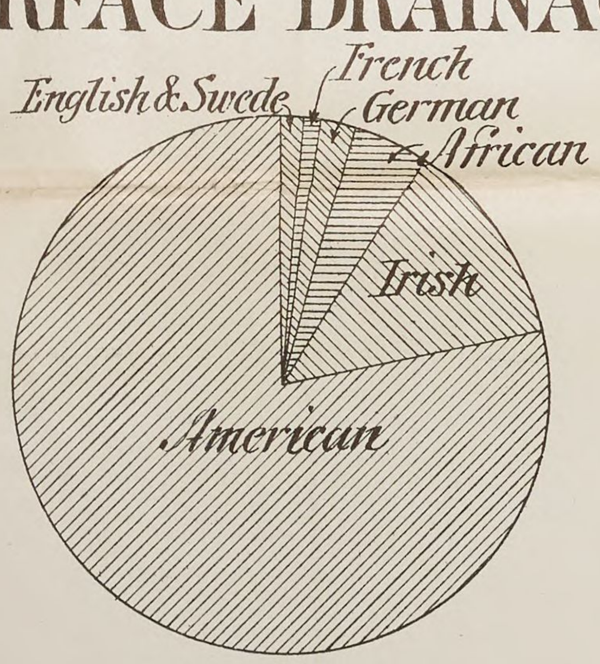
SURFACE DRAINAGE



SEWERAGE



NATIONALITY



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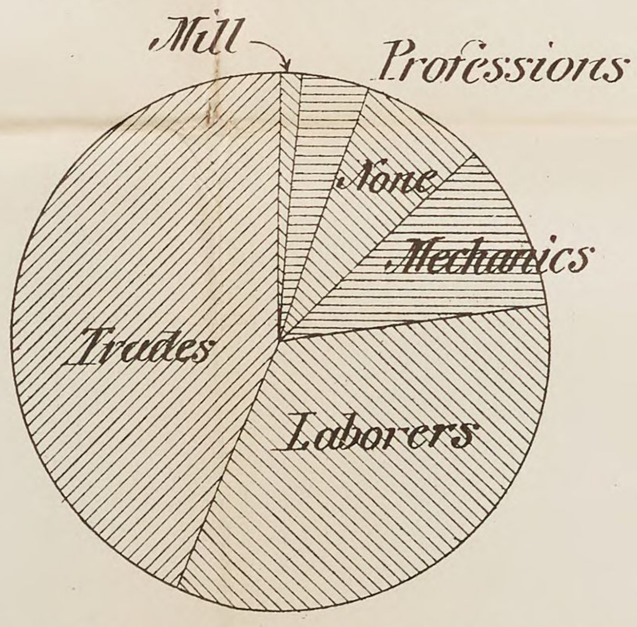
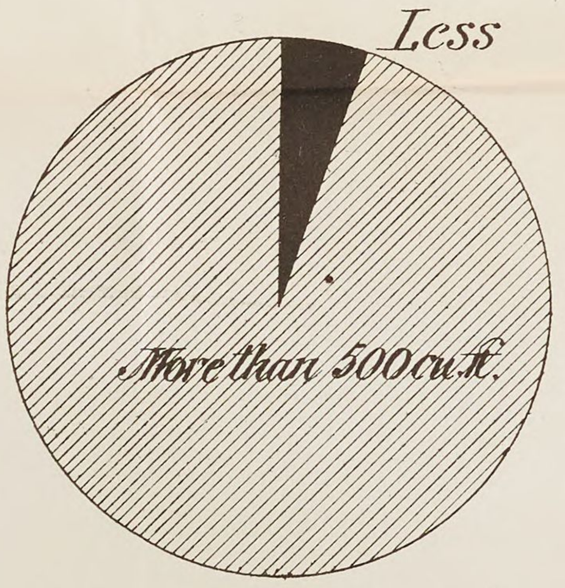
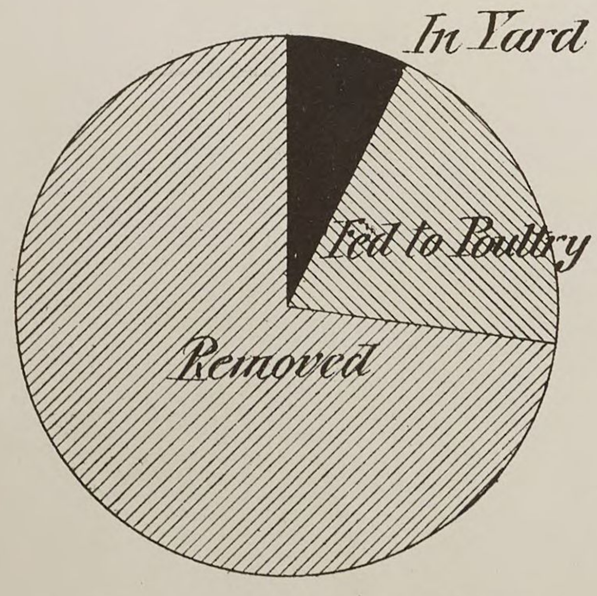


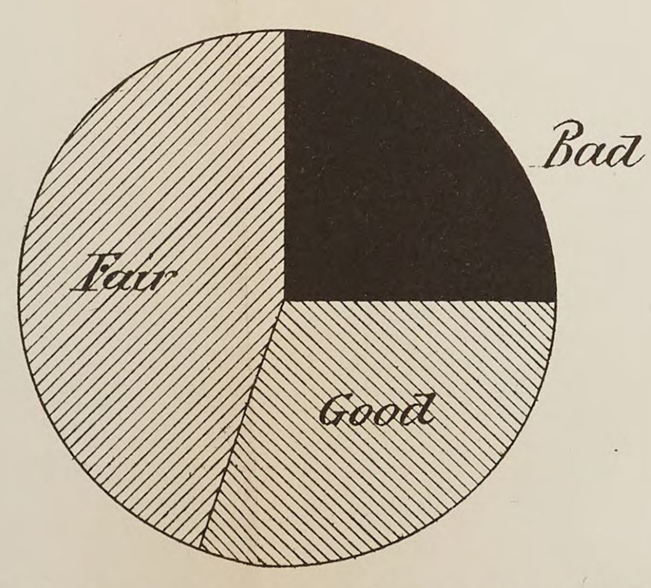
OCCUPATION



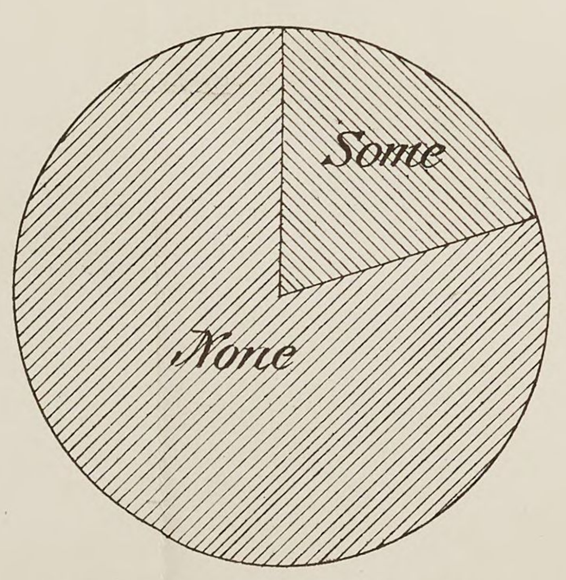
AIR SPACE



GARBAGE

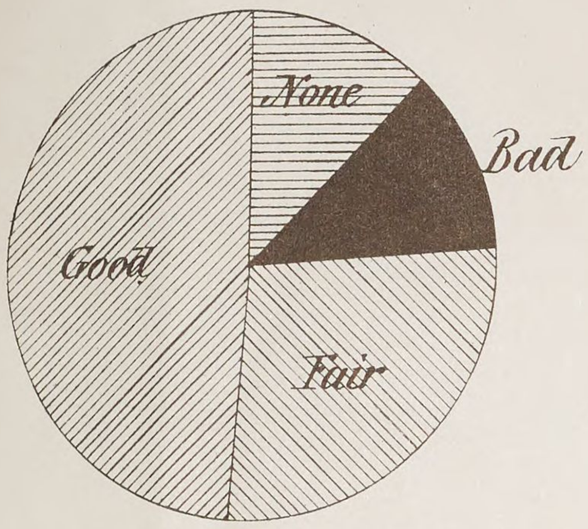


SURROUNDINGS

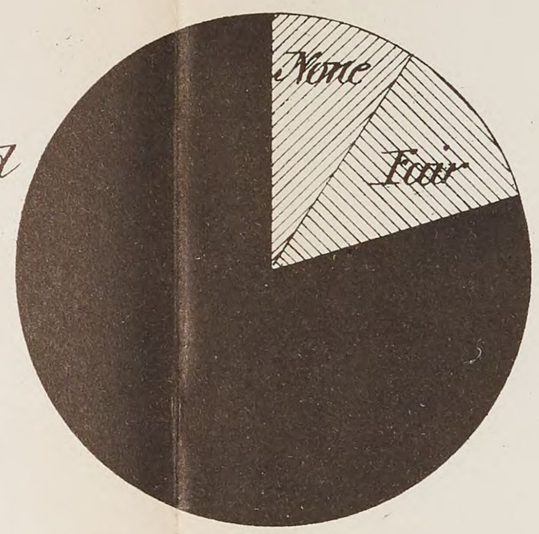


SICKNESS

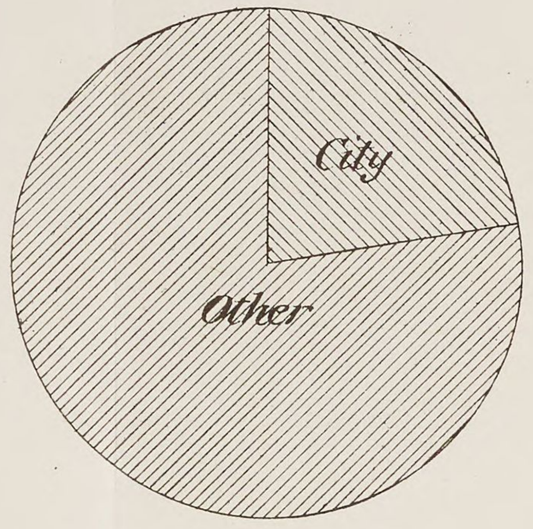
WARD 2



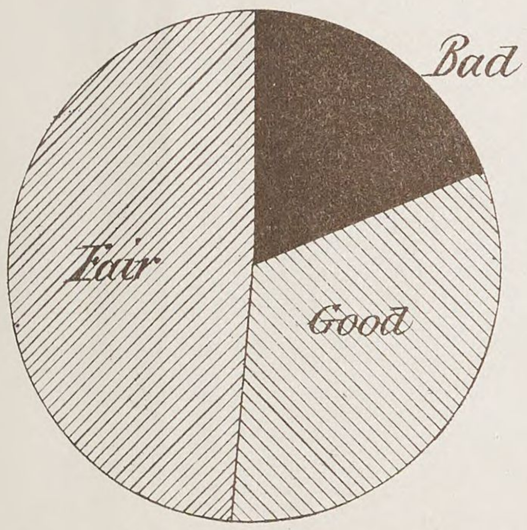
CELLARS



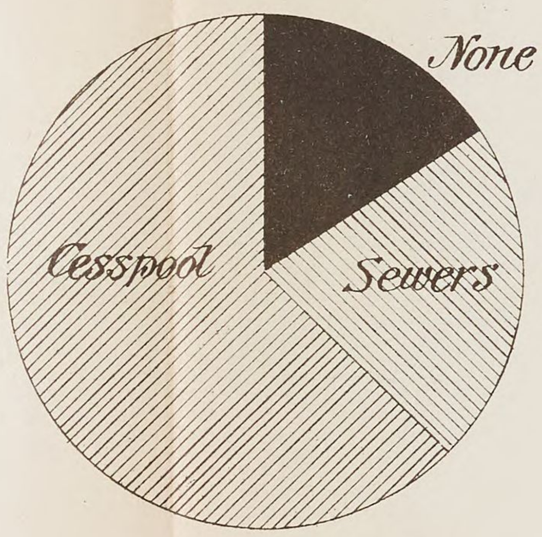
PRIVIES



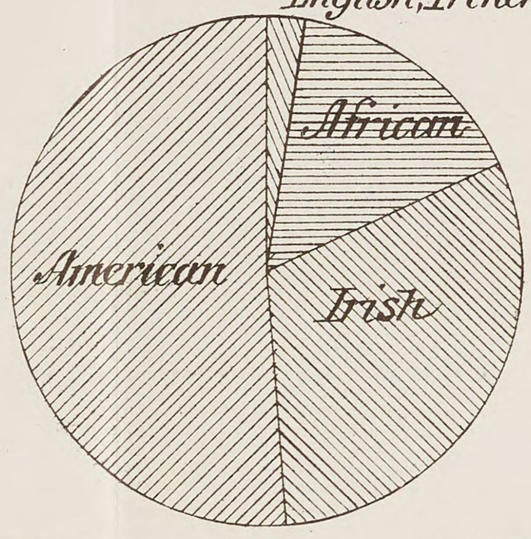
WATER



SURFACE DRAINAGE



SEWER



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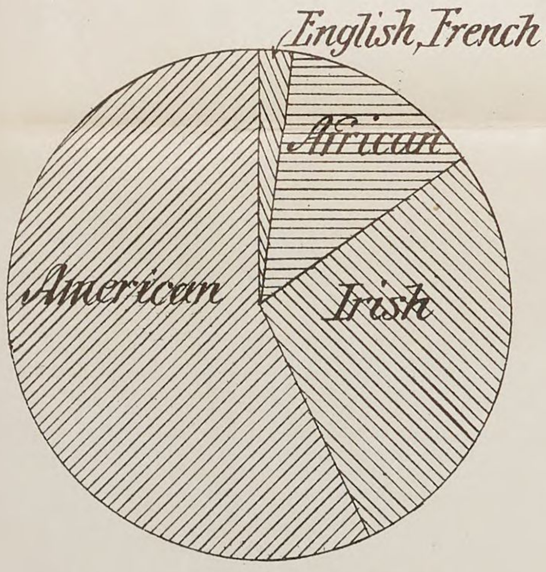

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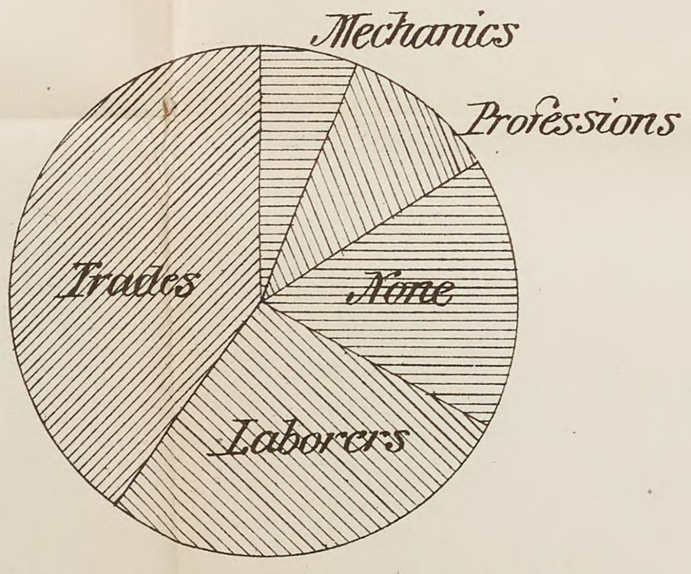
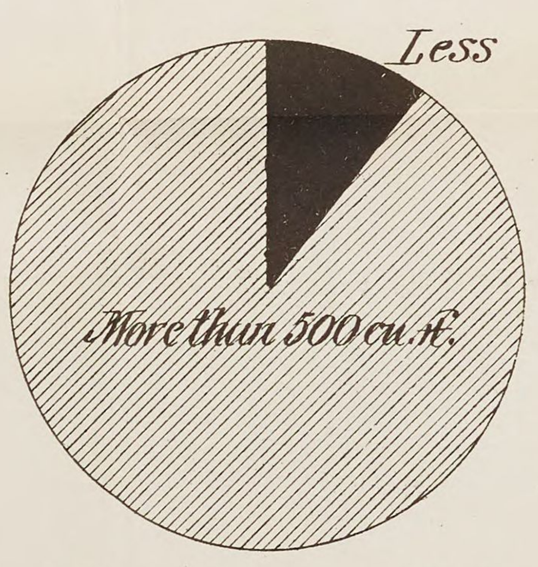
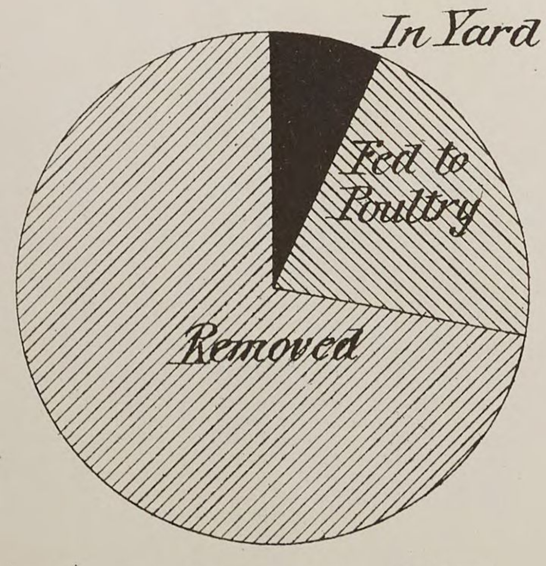


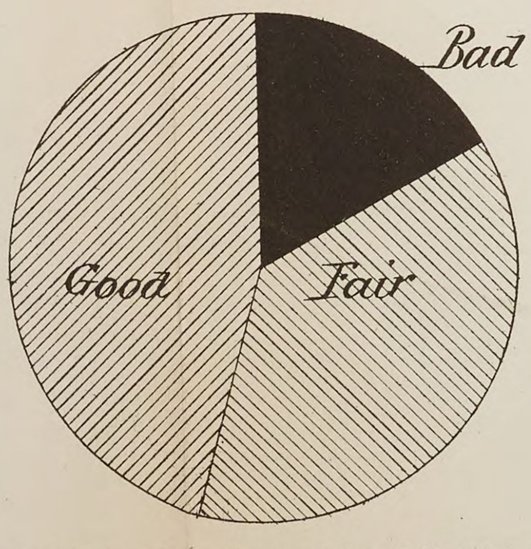
OCCUPATION



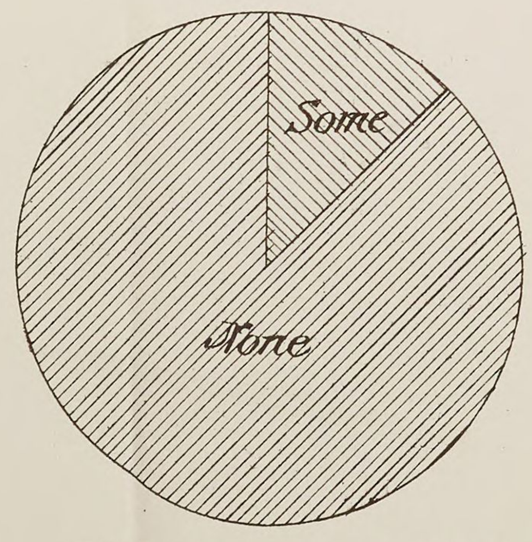
AIR SPACE



GARBAGE

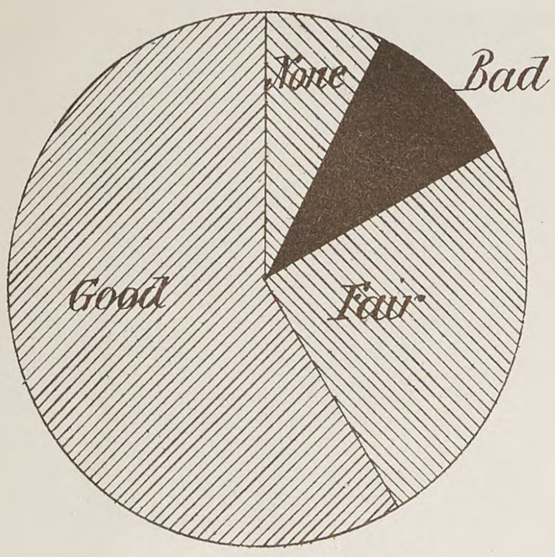


SURROUNDINGS

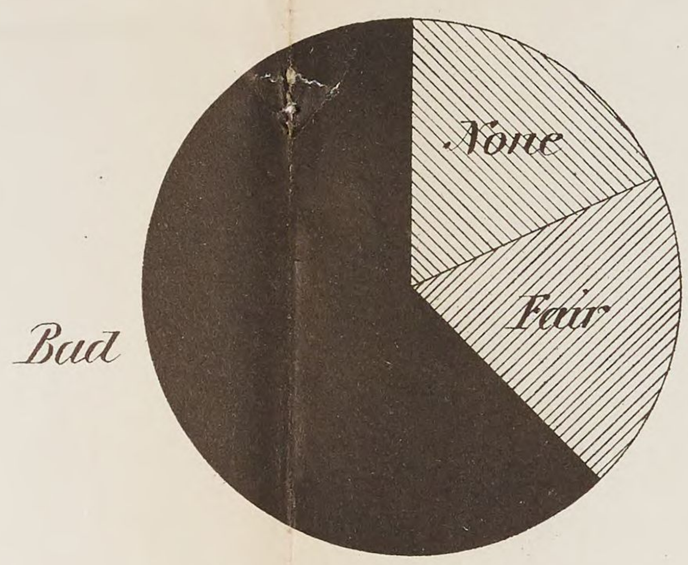


SICKNESS

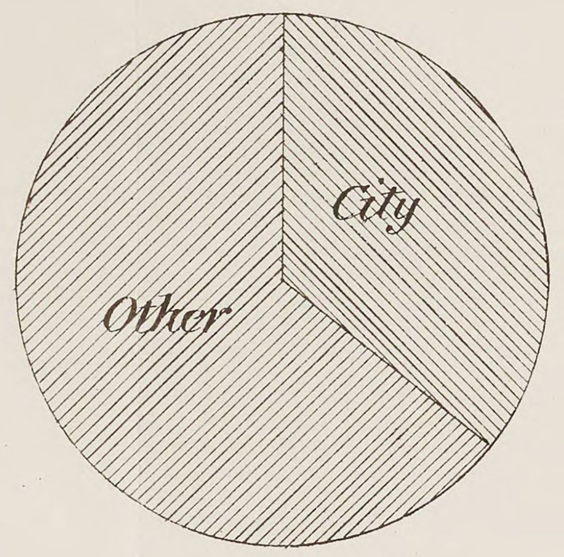
WARD 3



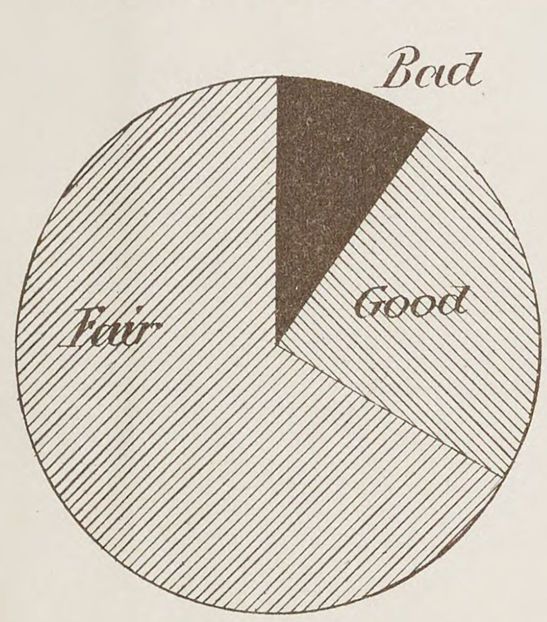
CELLARS



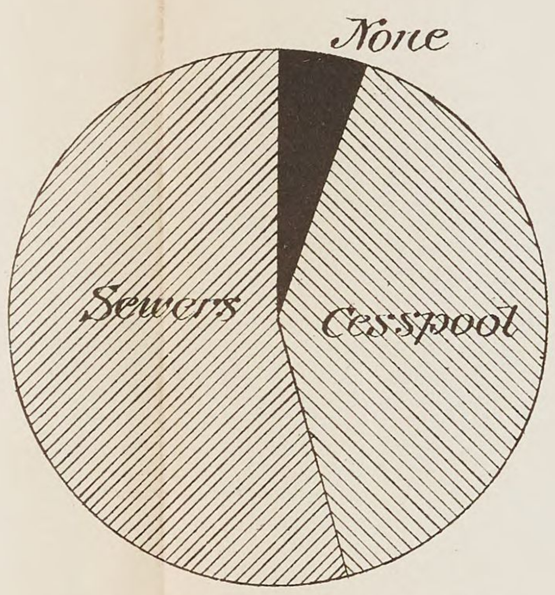
PRIVIES



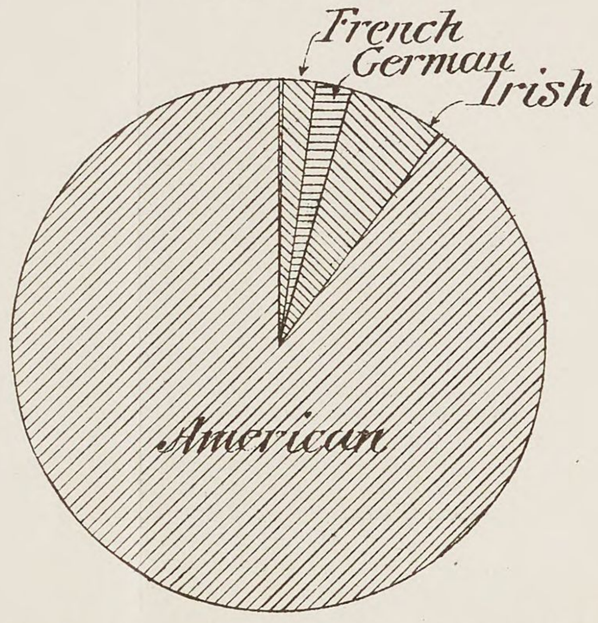
WATER



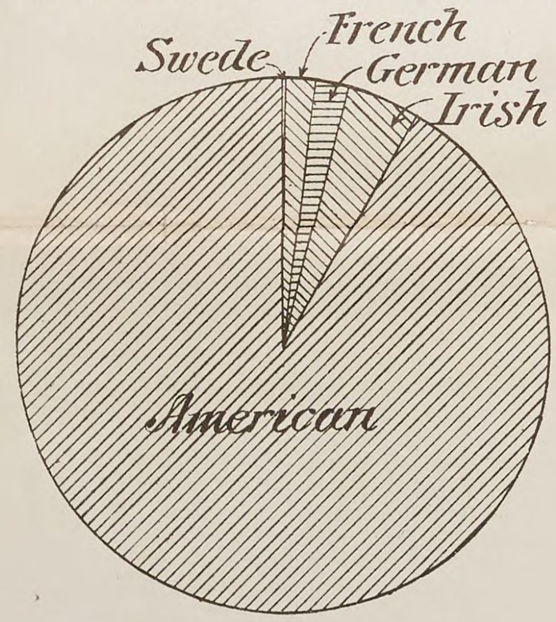
SURFACE DRAINAGE



SEWERAGE



NATIONALITY



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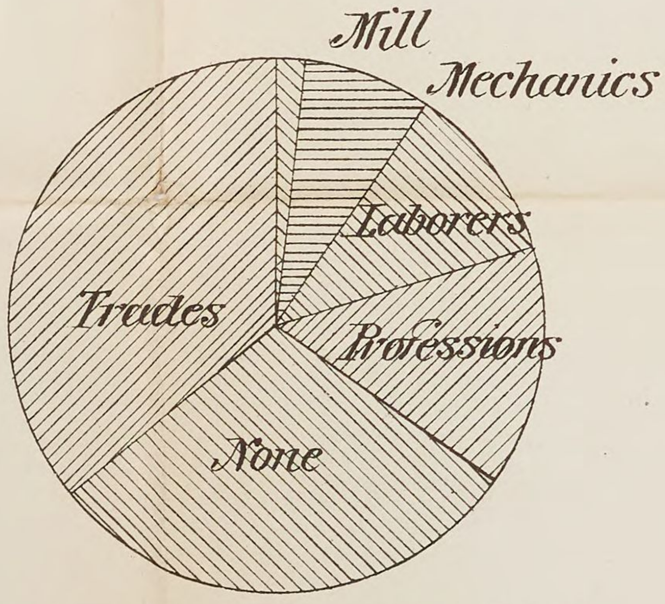
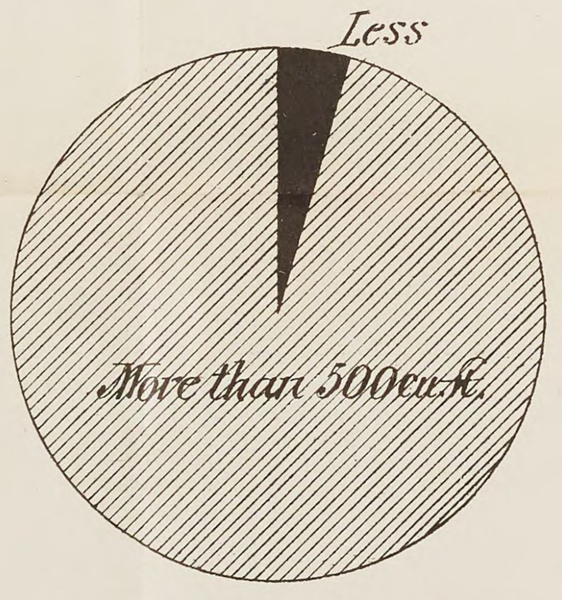
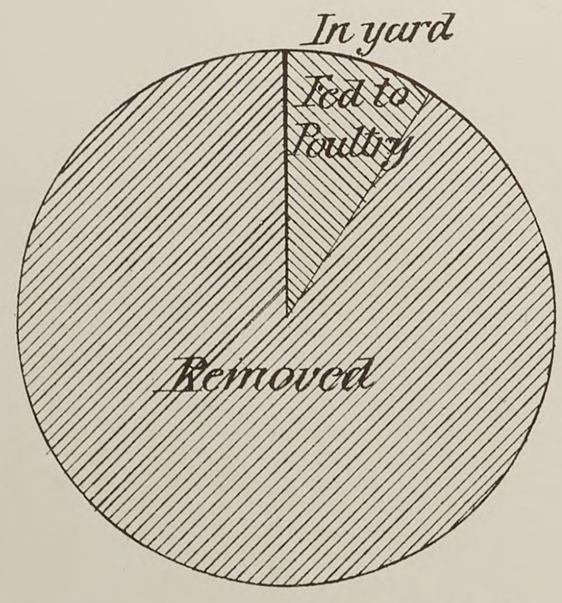


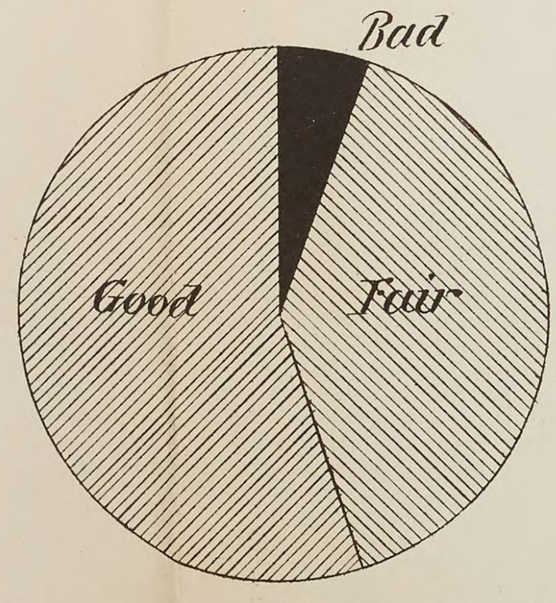
OCCUPATION



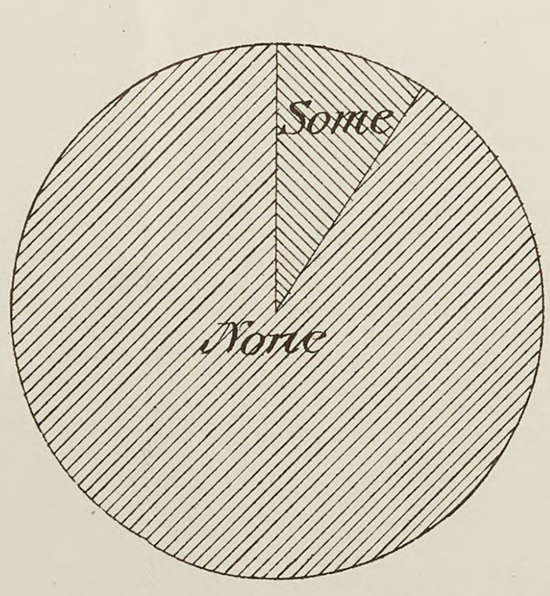
AIR SPACE



GARBAGE

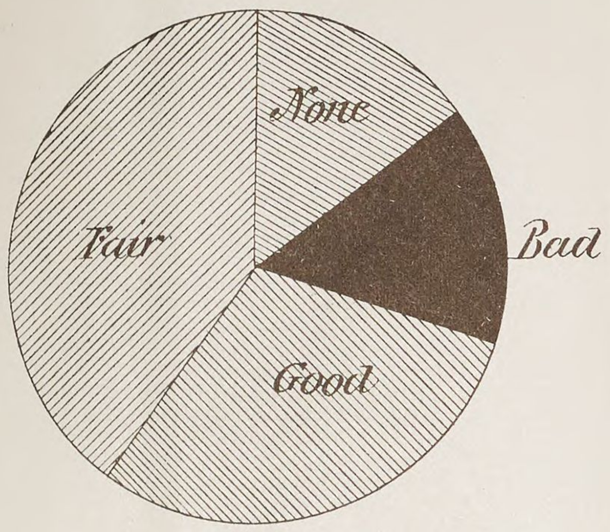


SURROUNDINGS



SICKNESS

WARD 4



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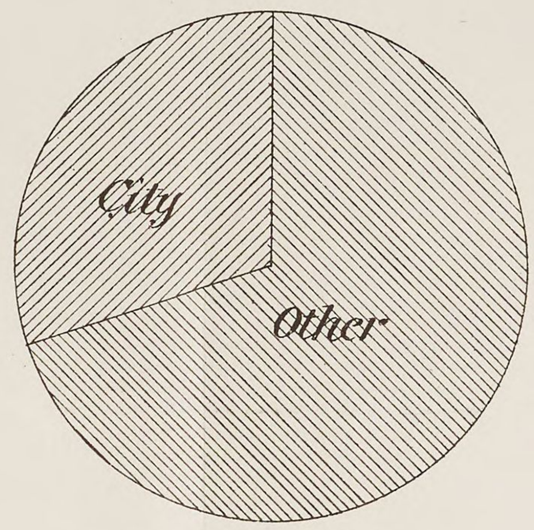

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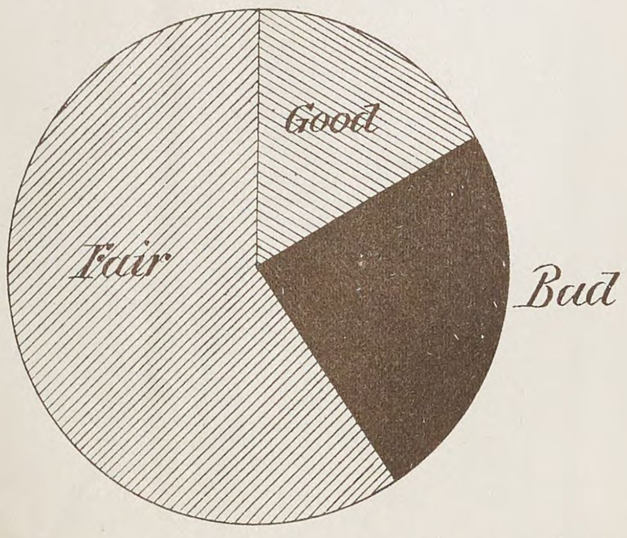

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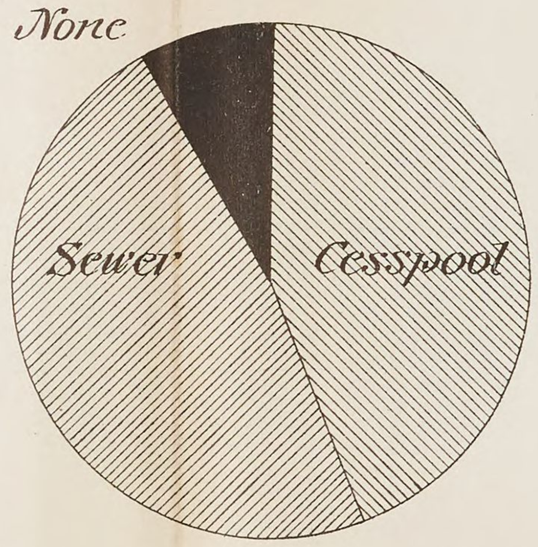

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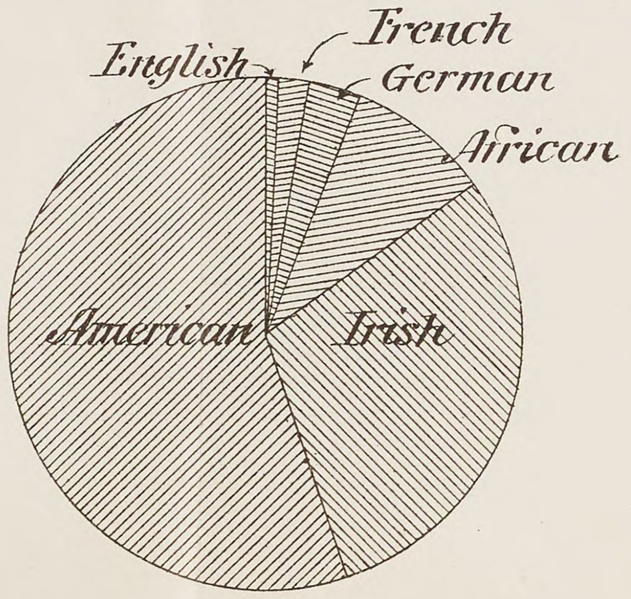

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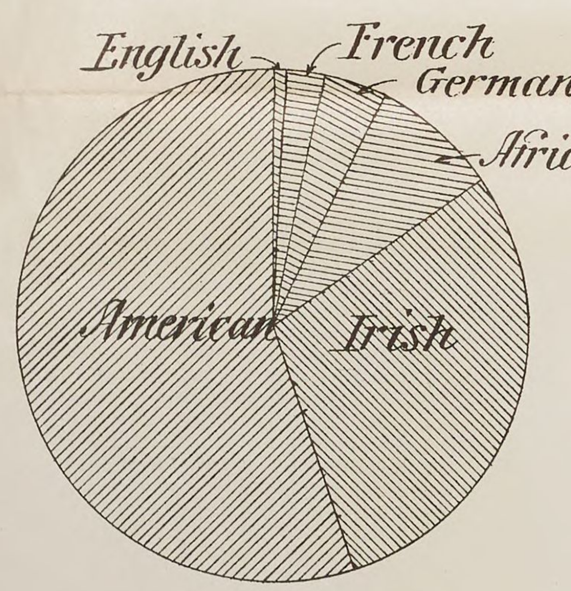

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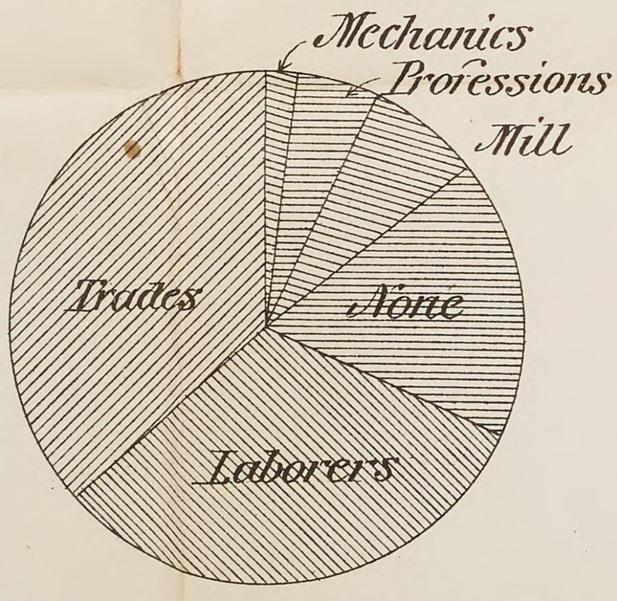

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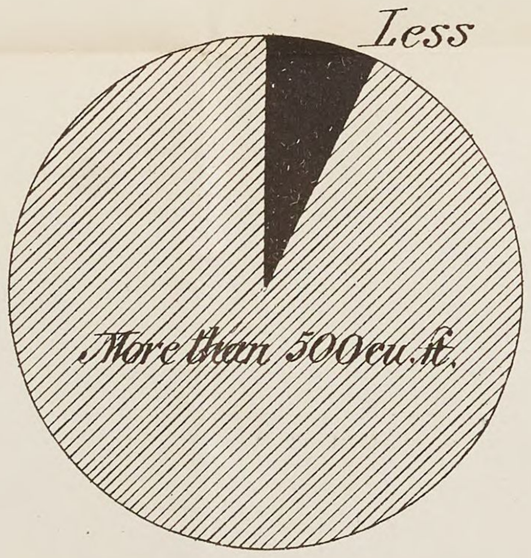

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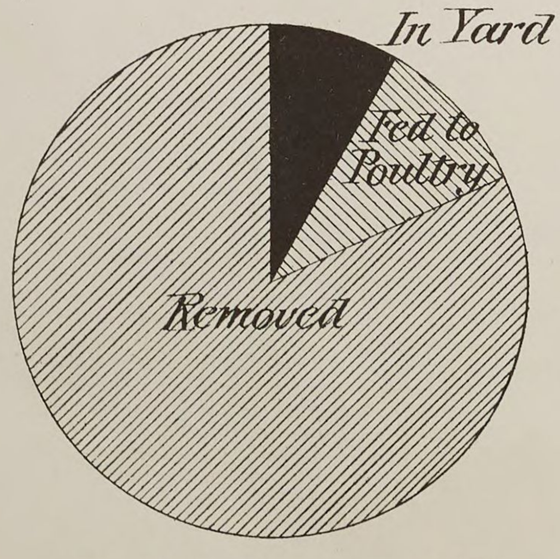

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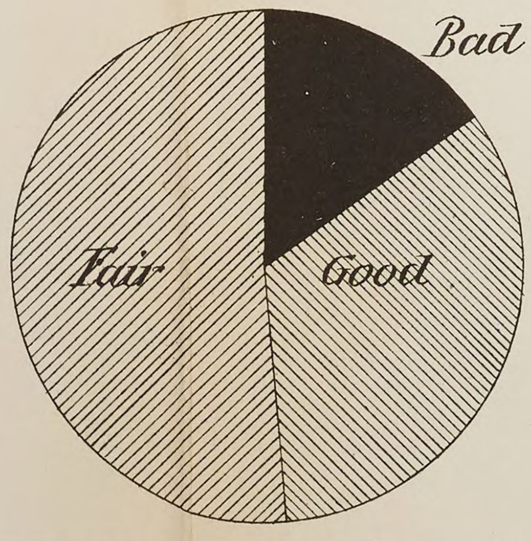

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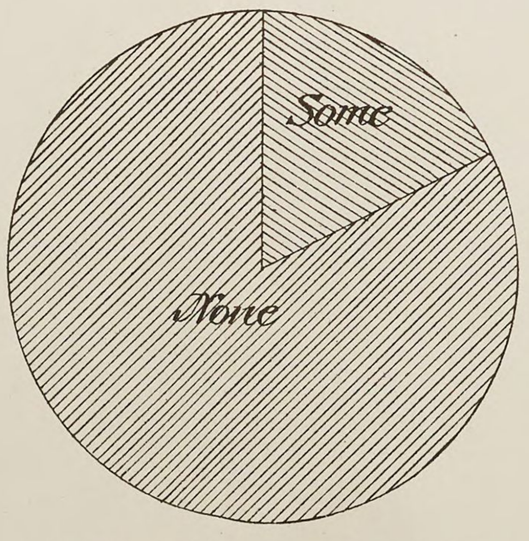

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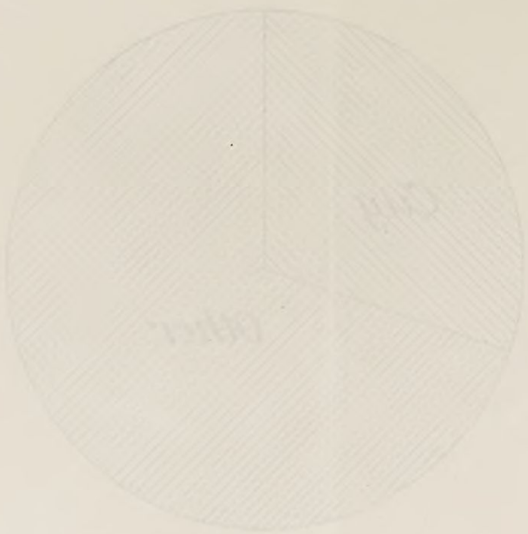

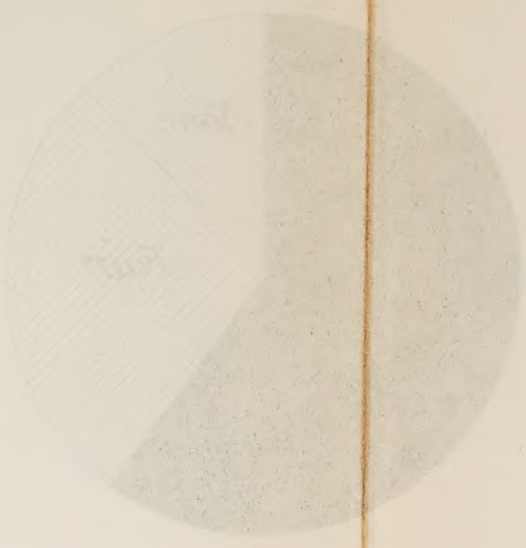

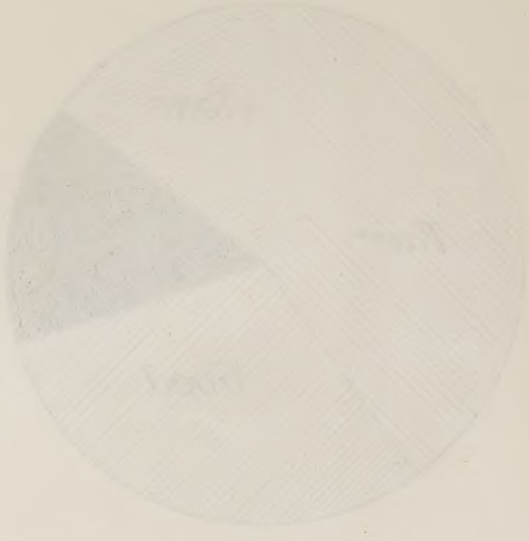

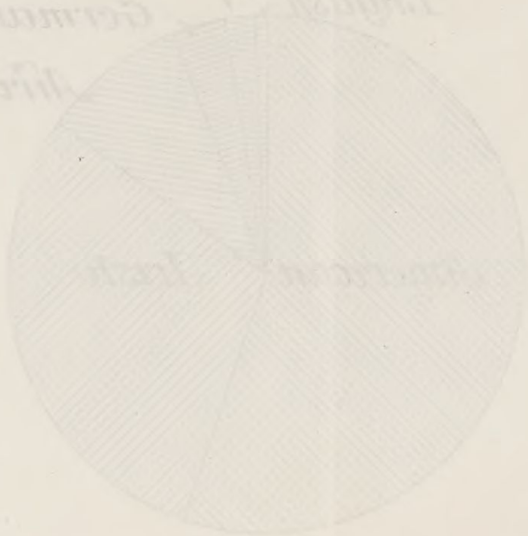

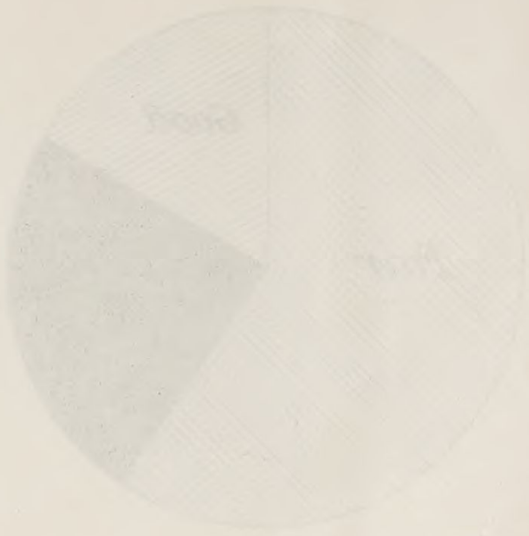

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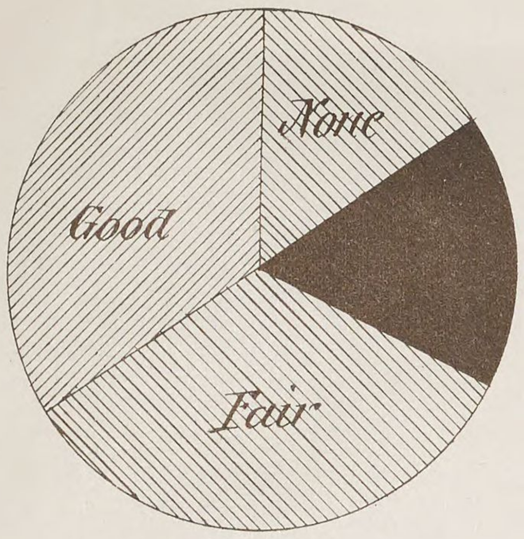

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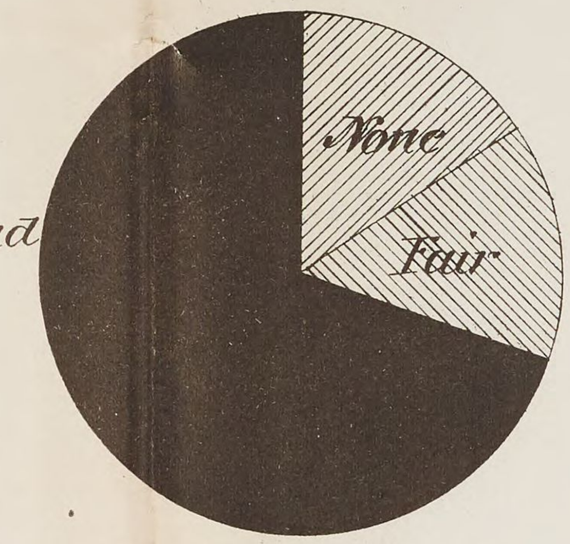

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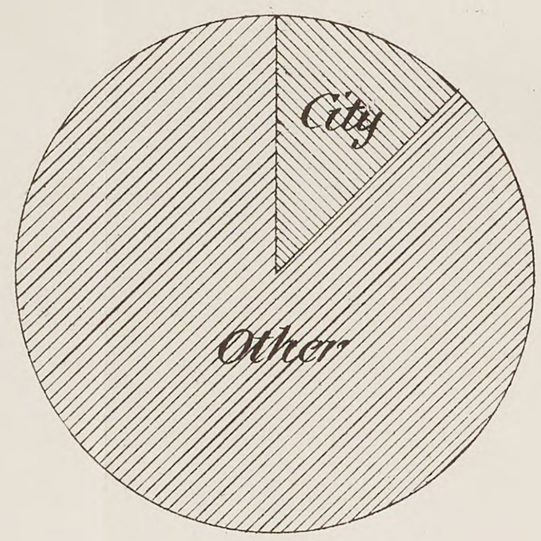

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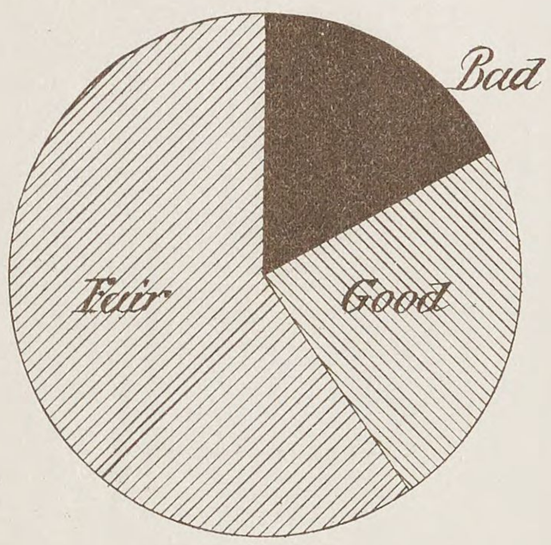

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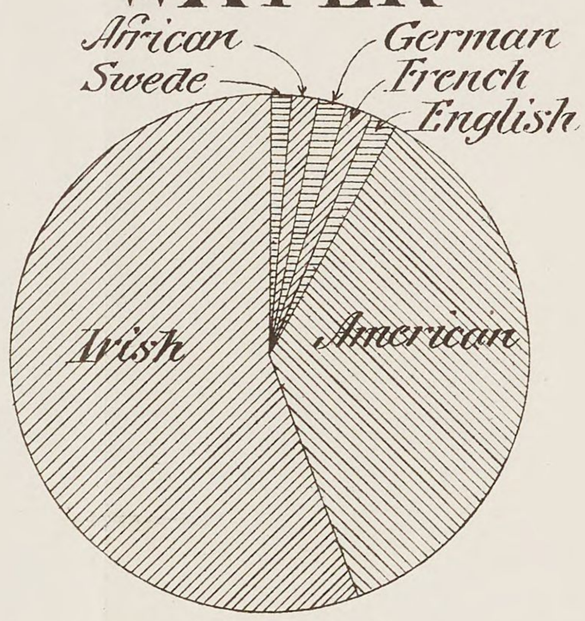

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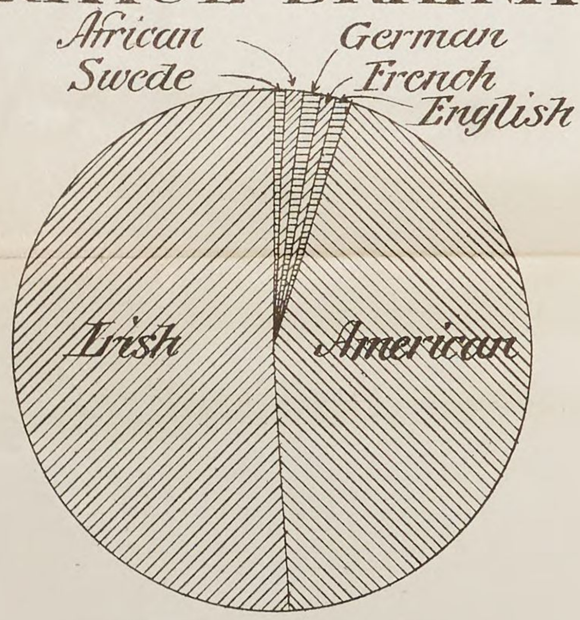

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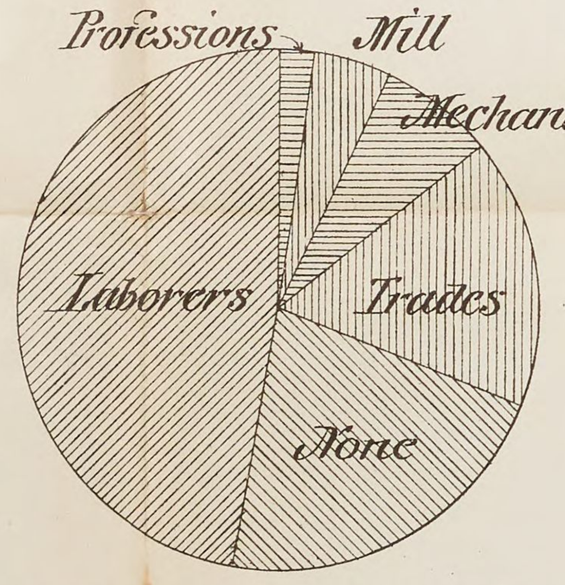

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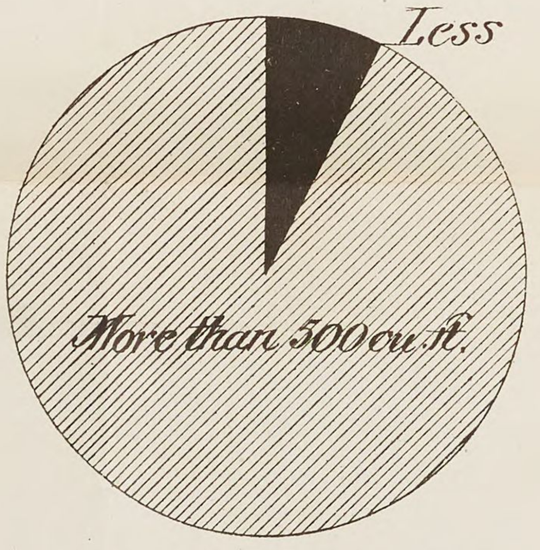

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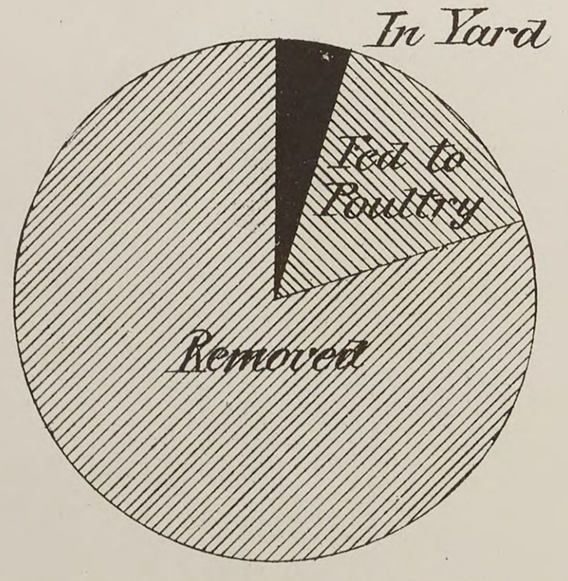

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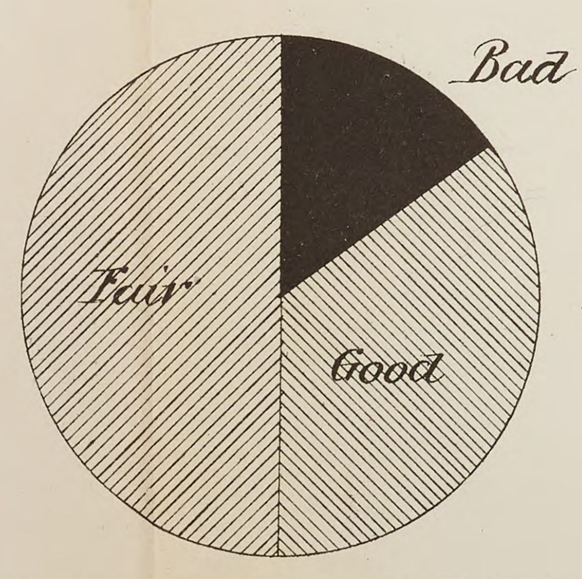

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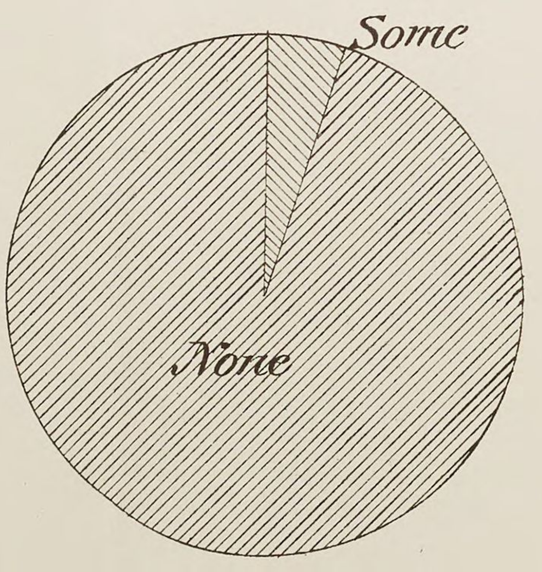

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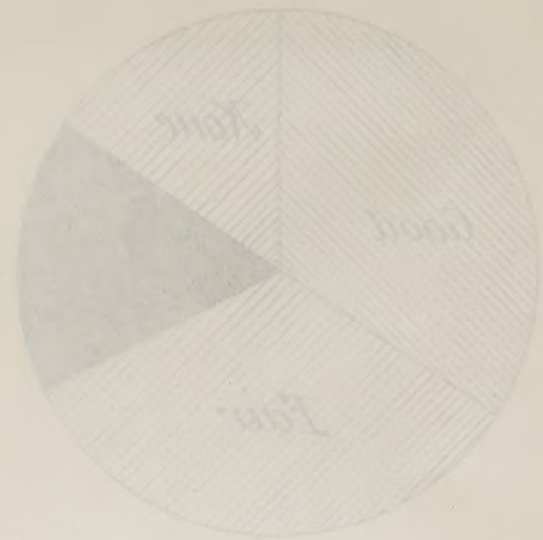
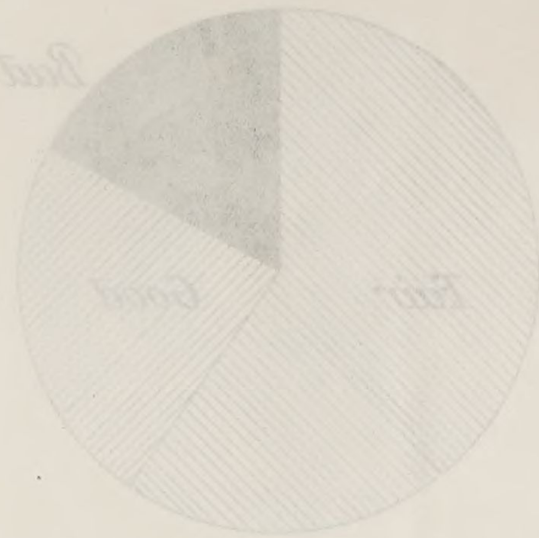


CELLARS

CELLARS

CELLARS



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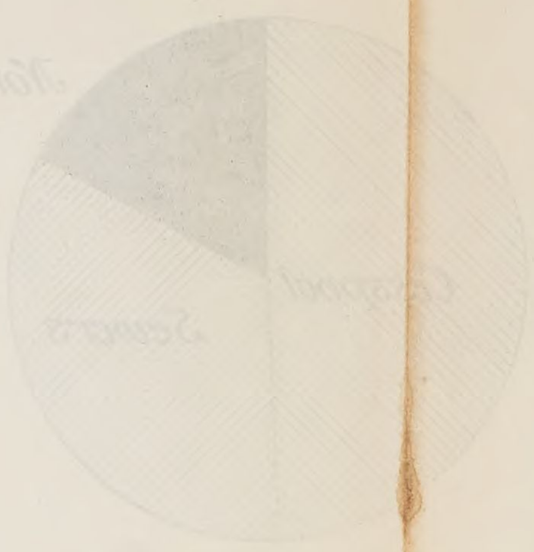

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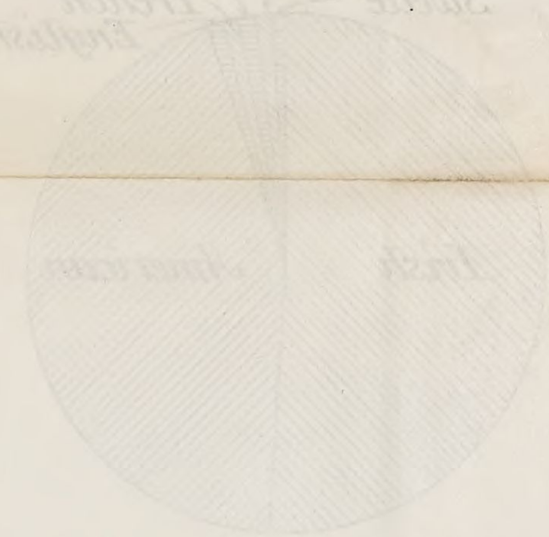

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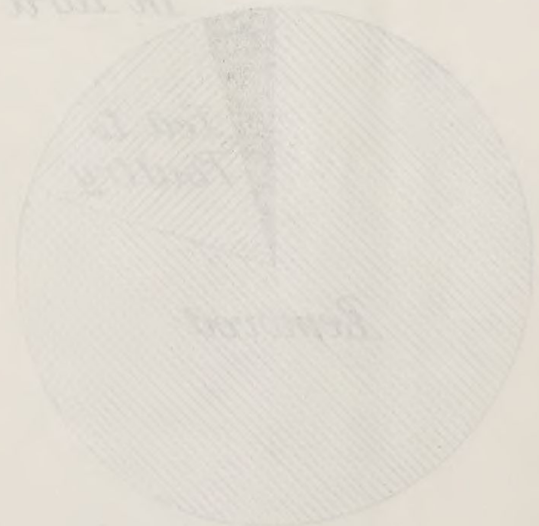

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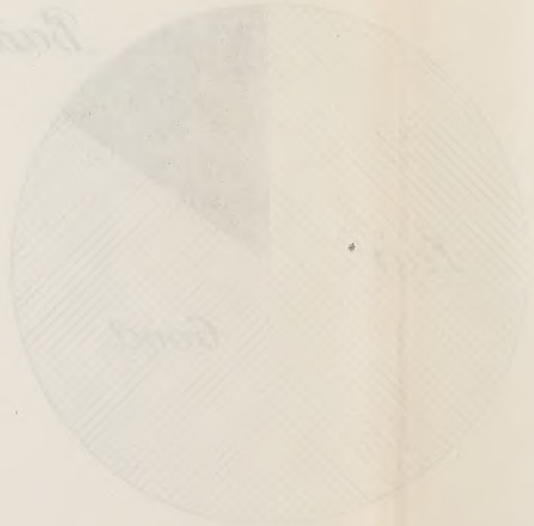

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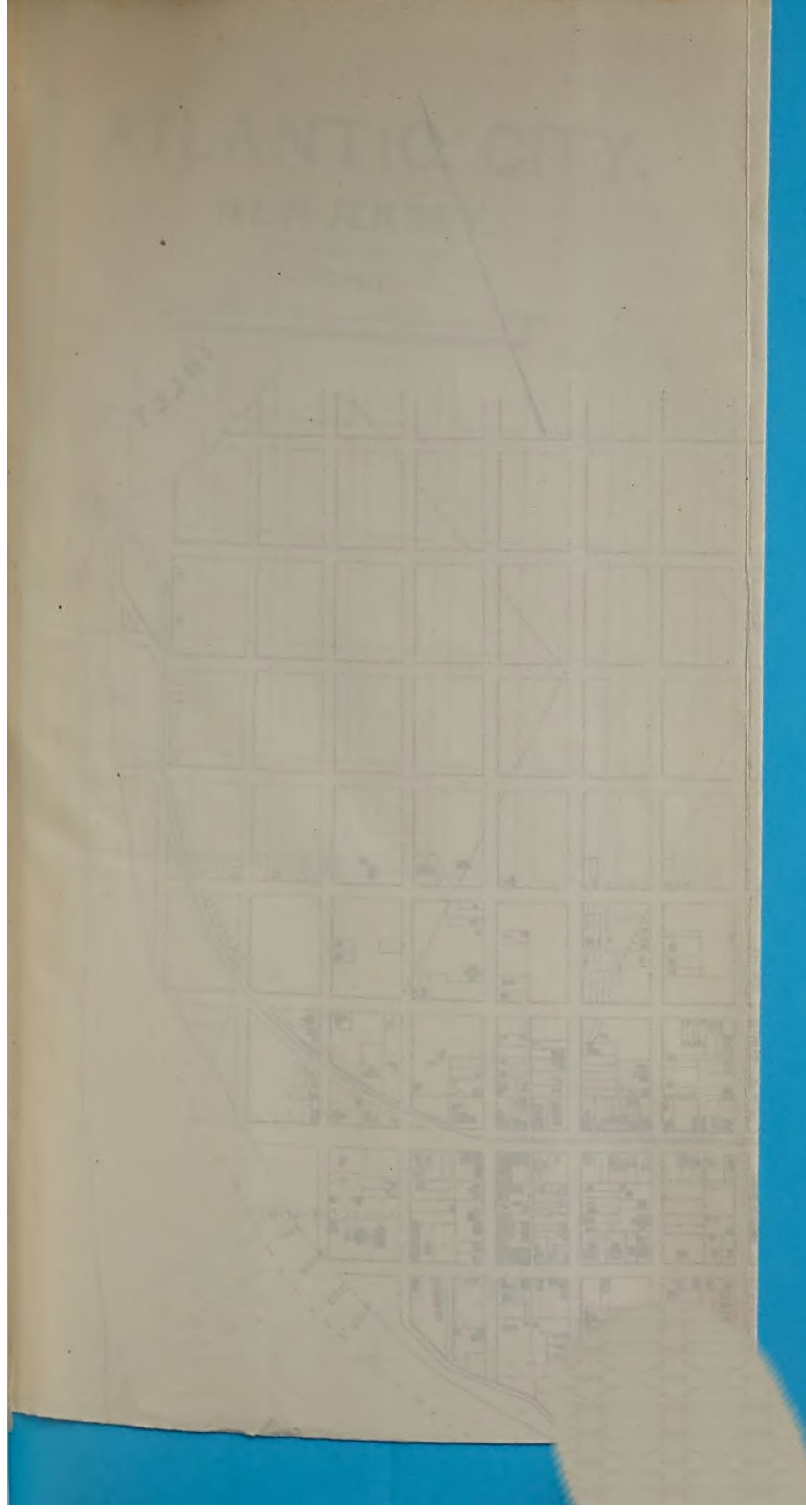


ATLANTIC CITY.

NEW JERSEY.

SCALE

0 300 600 1200 1800

ATLANTIC CITY.

Atlantic City, N. J., the favorite summer resort for Philadelphians and Baltimoreans, occupies a portion of a long, narrow, flat, sandy island, surrounded on all sides by salt water, and separated from the hard land by 7 miles of salt marshes. It is, naturally, as unattractive a spot as could well be selected, lacking good well water, possessing an extended but not specially pleasing prospect, and with a possible bathing beach perhaps 10 miles long, no portion of which seems to be free from dangerous undertow.

This island, three-quarters of a mile wide and 10 miles long, upon which the city is built, is separated from the marshes on the west by a deep creek, navigable for vessels through its entire circuit. The city water supply, introduced during the season of 1882, has been brought across the marshes from the hard land, the artesian wells in the city, sunk to a depth of over 800 feet (entirely through fine sand and gravel) failing to obtain water of even reasonably good quality. There are no brooks or other available source of supply on the island proper.

The resident population is not large, 6,000 perhaps being an outside figure, but this is swelled in summer to fully 50,000, and, at times, runs as high as 70,000 (for a single day), converting the city into a sort of Coney Island for the inland cities and towns near by.

The floating population, brought down daily by the several railroads, on trains exceeded in length and number only by those that leave Brooklyn and Bay Ridge for the breathing places on the southern Long Island shore, are accommodated in great wooden pavilions similar to those seen at West Brighton beach, Coney Island.

The cottage element is widely different, and occupies mainly those portions of the city apart from that given up to excursionists. Taken as a whole, however, the effect is very cosmopolitan, and perhaps on that account more interesting than it otherwise would be.

Until this season the only water used for drinking purposes was from cisterns. Not only cottages, but hotels accommodating hundreds of people possessed no other supply of potable water. The highest portion of the island being less than 12 feet above the sea, nearly all cesspools and many of the privies are built so that there is standing water in them at all times. It is exceptional to find one otherwise unless in the highest part of the island. This in itself would render the use of well water unwise.

Houses are obliged, by ordinance, to drain into cesspools, that are called tight, from having impervious sides, and sometimes tops. As the bottoms are, so far as noticed, invariably open, they should more properly be classed as modified leaching cesspools. Many are exceedingly primitive wooden structures, and some of the best hotels depend entirely on sunken boxes or barrels for the disposal of their kitchen sewage. Privy vaults are built in the same manner, and from those that at all times have standing water in them the stench is dreadful whenever the contents are stirred by the addition of further sewage.

In 1881 the sewers that existed were intended for surface water only. That this was wise seems evident, from the outfalls being at the rear of the city on the marshes, where sewage, if delivered, could scarcely be got rid of in any direction.

Of course where cesspools and privies are provided with open bottoms the soil pollution must become greater and greater every year, and, at Atlantic City, owing to the incredulity of people, it has been extremely difficult to apply the proper remedies, many residents still believing that because the level of the ground water rises and falls perceptibly, at times being coincident with the tides, that therefore all cesspool matter other than solids must work off through the soil, and so on to the sea, thereby entirely disappearing in an appreciably short time.

Such reasoning is fallacious, for when cesspool and vault matter are disposed of by soaking at such a depth below the surface, all proper oxidation is much retarded, if not entirely prevented, and foul matters remain latent indefinitely.

Wells.—Many tubular wells are found, from 12 to 18 feet deep, in various parts of the city. As might be expected, the water from these, though abundant in quantity, is foul and unfit for use in the houses. For drinking purposes, therefore, cistern water only is permitted (1881), and so desirable is this considered that houses are rarely occupied unless there be a cistern on the premises of satisfactory size, and having a sufficient supply of water in it. There seems to be no custom about the use of filters.

Cellars.—Till recently it was by no means universal to have cellars under the houses, because the water is so near the surface of the ground. Latterly, however, houses are provided with apologies for cellars, made by raising the first floors high above the natural level of the ground, and either banking around with earth or building lattice work.

The sanitary condition of the city in the past has justly been a subject of criticism; so much so that in May, 1880, a local board of health was appointed to attend to the cleanliness of the community. The board, which has proved itself a very stiff

new broom, has already accomplished many gratifying reforms, and while only a beginning has yet been made, whatever has been attempted has been carried out fully in detail.

For instance, garbage is regularly and carefully removed, in ingeniously constructed wrought-iron carts, with little or no annoyance to the public, once in every twenty-four hours from the cottages, and twice during the same period from all public houses. As a result the health of the city has been appreciably better. The service as now rendered seems, so far as it goes, both satisfactory and sufficient, and what has been accomplished has been done in the face of very considerable opposition.

A word should be said about the luxurious and cozy little cottage-hotels. So far as chambers, parlors, cooking, &c., are concerned, any one of the dozen or more that are to be found open the year round will prove as comfortable and pleasant as even an invalid could ask. It is to be hoped that the bath-room and kitchen accommodations will before many years be equally good; unless they are, Atlantic City hotels will scarcely rank where they should.

Along the New Jersey shore, but more noticeably south of Atlantic City, are numerous small communities of summer residents who live in very primitive fashion, lacking the freedom of a camp life, yet without many of the comforts of a civilized one. Houses are set on posts, garbage is piled indiscriminately on the ground outside, and shallow wells and barrel cesspools furnish water and dispose of sewage respectively. One of these settlements, perhaps better in architecture than the average, is a collection of houses built upon a fresh-water marsh, just back of the beach some miles south of Atlantic City. The buildings are very slightly above marsh level, not more than a few feet, and are built in the manner described above. A more undesirable location and general arrangement it is difficult to imagine. The public privies were intended to be cleanly and of proper pattern, but at the date of visit (May 22, 1881) they were very filthy and the iron boxes full to overflowing with fæces and rain-water. By accident or design the public privies are located to the windward of the houses, and it is stated that a bad smell is frequently noticeable from this source. It is not to be understood that this state of things is confined to this one place, or even to the Jersey coast, for similar instances can be found at intervals all along the shore to Mount Desert, and are most numerous, perhaps, at Martha's Vineyard and on Long Island.

LONG BRANCH, MONMOUTH BEACH, AND SEABRIGHT.

To the north of Atlantic City, on the coast, beginning at the northern extremity of Barnegat Bay, is a succession of summer resorts, occupied by thousands of people, many of whom go daily to New York. Point Pleasant, Brielle, Manasquan, Sea Girt, Spring Lake, Ocean Beach, Asbury Park, Deal Beach, Elberon, Long Branch, Monmouth Beach, Low Moor, Seabright, and Highlands join each other and occupy most of the coast between Point Pleasant and Sandy Hook. Perhaps a description of those most widely known will answer for all, more especially as they furnish at once examples of the best and the poorest on that portion of the coast.

"The Elberon" originally comprised twenty-five cottages and a small hotel, though latterly the fashion has been to extend the limits of the territory covered by the name, until now it is understood to be the court end of Long Branch (summer town) rather than a distinctly separate establishment.

Elberon Hotel, built in 1877, exhibits the first instance of intelligent hotel plumbing and general sanitary arrangement, combined with careful maintenance, met with in New Jersey. Probably many of the details might be somewhat differently arranged with advantage, but the work is well planned and properly carried out. The outfall of the sewer on the beach might perhaps be improved and the cesspools omitted entirely, but in point of maintenance it is second only to the Ocean House at Newport, R. I. There is both well and public water.

Long Branch village (winter town) is not, as many suppose, on the water, but, on the contrary, is half a mile inland. The summer town, however (which joins the winter town), to the north of Elberon, is back from the cliff only so far as is requisite for an avenue and a narrow park on the water side. At West End, where the avenue turns an abrupt right angle, and just south of the celebrated iron pier, is the first of the large hotels, many of which face the avenue, within Long Branch limits.

The public water-works at Green's Pond, on the northern edge of Elberon, and half a mile south of West End, supply water for Long Branch, Monmouth Beach, and Low Moor, the requisite pressure being obtained by a stand-pipe. Of sewers it may be said there are none from Elberon to Sandy Hook, though there are one or two exceptions—notably the Elberon Hotel referred to, where the overflow from cesspool runs to the sea, and the Ocean Hotel, Long Branch, where a pipe is carried out under the iron pier a distance of 900 feet. Fortunately the soil is for the most part sandy over the entire distance between Deal Beach and Sandy Hook, so that the public water can be leached away through cesspools for a long period without serious trouble. At the large hotels, accommodating from 1,000 to 1,600 guests, one would expect to find

the cesspools most troublesome, more particularly, perhaps, in connection with thos- public houses whose lawns and yards are contracted in size. This supposition is ene tirely borne out by facts. Some of the back yards are literally honeycombed with cesspools that, one after another, becoming clogged with grease and other filth, have been discontinued. To such an extent is grease troublesome that at one hotel, where the distance between scullery sinks and cesspool is longer than usual, and less fall to the drain, the whole line of pipe is taken out and replaced once every season, being entirely choked with grease. Occasionally it is necessary to go through this opera- tion twice.

But one hotel, so far as known, makes any effort to separate the grease from the waste water, but imperfect as the process is it has prevented some two tons of grease from passing through the pipes each season since the experiment was first tried.

At the Ocean Hotel is perhaps the best instance of a large and properly maintained earth-closet (privy) that has been seen anywhere. Twenty-eight closets (on two floors) empty into a brick vault. Earth (salt sand) is sprinkled three times daily upon the deposits, and the vault is free from offensive smells.

A portion of the sewage of the Ocean Hotel is carried through a six-inch wrought iron pipe into deep water under the iron pier, delivery being into a sheet iron tank having a perforated cover. This was carefully and thoroughly done, but the sewage from 1,000 people delivered at one point, only 900 feet from the bathing beach, is sometimes disagreeably noticed at the latter place. The other hotels, so far as visited, were all inferior both in construction and maintenance, so far as their sanitary arrangements were concerned. It should be mentioned that the water-closet tower of the West End, which is separated from the hotel proper, is kept sweet and clean, and must add very much to the comfort of the hotel. The maintenance throughout the hotel appeared to be excellent, but the principle of so large a building depending wholly on cesspools is wrong and should be superseded as soon as possible by sewerage.

Before leaving Long Branch hotels it may be well to call attention to an arrange- ment which in a more or less modified form is not infrequently met with, but that in any form seems undesirable, and scarcely as cleanly as might be.

Swill rooms appear to be a New Jersey invention. They are at times under a portion of the carving room and kitchen, or, what is unusual, on the same level. When located underneath the garbage is dumped into a hopper and falls directly into the room or vault, or sometimes into a cart that may be there for the purpose. When on the same level a wheelbarrow or buckets are made use of. Frequently the vaults are of brick, lacking adequate ventilation, and kept in permissible order only by repeated applications of chloride of lime. Instances are noted where refrigerator wastes drip untrapped into the swill room.

In warm weather few things are more disgusting or nauseating than sour, partially decomposed garbage, and the principle should always be to carry it off the premises as soon as possible, as is done at Atlantic City.

At Monmouth Beach there is but one public house, and that one is used largely by cottagers in the neighborhood who go there for meals. From this point to Sandy Hook the land between the ocean on one side and Shrewsbury River on the other, is quite low, much of it marshy, and is in places so narrow as to afford room for but a single row of lots on either side of the avenue. In fact most of the houses are on the ocean side only, and the stables on the other. The difficulties attending proper drain- age are here shown in an aggravated condition, and the black, stagnant sewage near the railroad at Monmouth is suggestive of trouble in the near future, the beginning of which perhaps occurred in 1882 at a summer hotel in Seabright. The cottages on Monmouth, Low Moor, and Seabright beaches are all of the better class, except the remains of the fishing village and life-saving station at the latter place.

At Seabright, opposite Navesink Highlands, the land is so low that it is difficult to obtain sufficient fall to run the sewage anywhere except into Shrewsbury River, and though this is done occasionally the remedy will be apt to prove more serious than the disease. The public water furnished from Green's Pond was not pleasant to the taste during the season of 1881, though the analysis made of it December 15, 1881, showed it to be "an excellent surface (weir or pond) water." At times during the summer, strings of green slime were occasionally drawn from the pipes, and the water proved cathartic in quality. This may have been due to a variety of causes, though the source of supply is not altogether what could be desired. A very considerable sum of money has been expended on the water works since that date, and much more will undoubtedly have to be spent before it is entirely satisfactory. It is particularly im- portant that Monmouth and Seabright should be furnished wiih a plentiful supply of the best public water, as the low character of the land and the use of leaching cess- pools renders well water as doubtful a benefit as at Atlantic City.

While recognizing the fact that it is far easier to criticise than to suggest adequate remedies, yet it is certain that before many years the whole coast from Navesink High- lands to Deal Beach (21 miles) must be sewered on some comprehensive plan, or there will be trouble.

That a satisfactory system can be designed does not admit of a doubt, though the least expensive arrangement for effectually disposing of the sewage of so large a district will require some little study, and, more than anything else, an intelligent co-operation on the part of various towns interested.

In general, it may be stated that the watering places on the Atlantic coast of New Jersey are all more or less in a transition state, that few have adequate water supplies and none are supplied with sewers—that the plumbing is for the most part poor in planning and construction, but that the maintenance, as a rule, is good while some is excellent—that without exception hotel-keepers and others express a desire to have their premises in good order, both inside and out, if a way were but pointed out.

Many of the towns and villages have large populations, and their sanitary condition is becoming of the utmost importance. The bulk of the seaside places are as yet summer resorts only, though each year sees a larger number of winter guests, and at some communities, notably Atlantic City, the winter season has become quite an important factor in the municipal economy.

BAR HARBOR.

Bar Harbor, a village in the town of Eden, Mount Desert, Me., is, without doubt, at the present time the most popular watering place on the whole Atlantic coast. It faces north and northeast, towards the Sullivan Hills and the upper end of Frenchman's Bay, the mountains of the island coming close to the outskirts of the village on the other two sides.

As there appear to be at least half a dozen other places on the island where the physical conditions would seem superior, and that are geographically more accessible, just why Bar Harbor was the one place on Mount Desert that attracted people the most is a question that has never received a satisfactory answer.

The soil at Bar Harbor is for the most part a stiff, retentive blue clay, holding considerable water, sufficient in quantity to render even some of the higher portions of the village decidedly wet in mid-summer.

To the westward of the village, 1½ miles distant among the mountains, is Eagle Lake, a beautiful sheet of water finding an outlet through Duck Brook to the salt water at a point perhaps a mile north of the village. Just below the lake, Duck Brook is dammed, making a reservoir, from which the public water is drawn. Until 1882 this was carried in a wooded sluice, sometimes covered and at other times open, across pastures and wild land to a second reservoir or tank, constructed of wood, immediately adjoining the village. From this last reservoir the service pipes, of iron, deliver water to customers throughout the village. This public water, up to 1881, was used only during seven months in the year, the old wells in existence previous to the introduction of public water being brought into service again during the winter. In 1881 a new reservoir, having capacity of some millions of gallons, was built of earth on the line of the sluice connecting the two reservoirs, and a 9-inch cast-iron pipe laid over a new line from this new reservoir to the village. This gave a greater head of water (185 feet) and furnished a much more abundant supply. The old tank was very leaky, and the flume lost more water along its line than it delivered at the tank.

The water works are owned by a private corporation, which increases the facilities as fast as there is any demand. So popular has it been that at the present time it is rare to find a house in the village supplied with either well or cistern water.

There are three main public sewers in the village, and in addition all the laterals necessary to give the best service to the entire community. For some reason, unknow to the writer, all sewers are cement pipes, 8 inches in diameter, and with manholes placed from 500 to 600 feet apart, in every way intended to secure the best of sewerage. Five thousand dollars of the public money was spent on this item alone at Bar Harbor during 1881.

All main sewers are intended to discharge below low water, and this is necessary, because sewage deposited on the shore from drains discharging at a higher level has already made itself obnoxious at one or two points.

All the principal hotels (there are nearly twenty of them) and most of the cottages are more or less thoroughly plumbed and their drains connected with the sewers. There are very few privies in use in the village, everybody preferring and using water carriage, while cesspools are equally rare. Curiously enough there is to be found here, side by side, some of the worst cases of "skin" plumbing and others of the most beautiful construction and ingenious planning. The reason is evident enough. Till comparatively recently Bar Harbor was a fishing village, where the occasional summer tourist was fed mostly on salt fish, doughnuts, and huckleberries. The few cottages that constituted the village depended upon wells and cesspools, or perhaps wells without cesspools, for their water and drainage. Suddenly Bar Harbor became a fashionable watering place, the fishermen's cottages gave place to great tinder-box hotels, each accommodating hundreds of people; and the little primitive fishing vil-

lage of twenty years ago is to-day provided with macadamized roads, water works, and sewerage, with street lamps, telegraph, daily papers, and a club. At first the people failed to realize the change, and retained the wells and cesspools, till the typhoid outbreak at the old Bay View House, caused by a leaky drain, brought them to a realizing sense of the situation. Aside from the painful results of the cases of typhoid referred to, probably there could have been no more useful lesson given to the citizens, and the present sanitary arrangements are the legitimate result of the changes begun at that time. Even "skin" plumbing has the merit of being a move in the right direction.

As a rule, the private houses are better plumbed than the hotels, and many of the latter will have to be entirely replumbed before they can be considered satisfactory; but the gratifying fact is everywhere observable that without exception householders express anxiety to perfect their drainage arrangements so that there can be no question in regard to them.

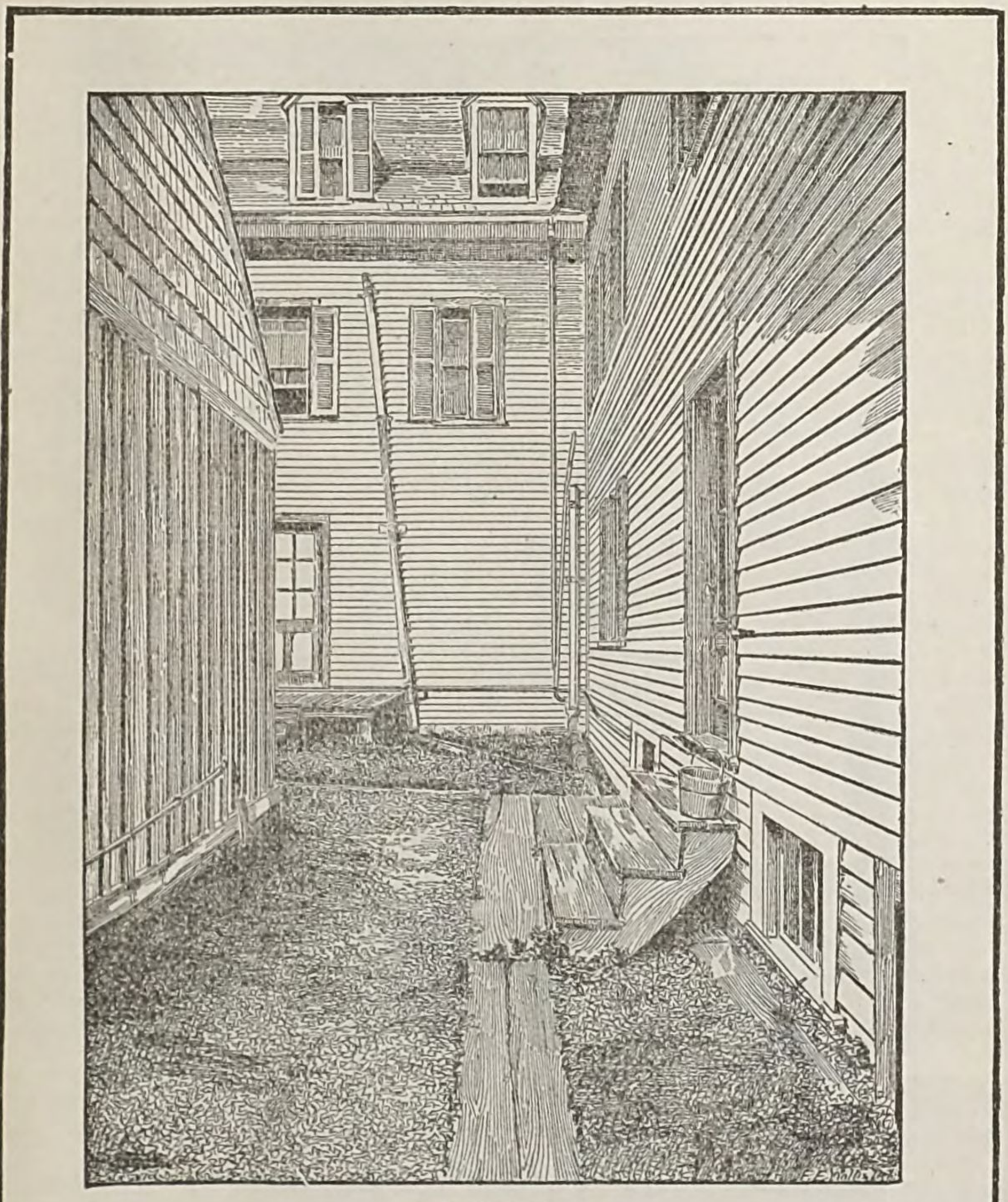


PLATE I

The English plan of having the soil and main waste pipes outside the walls of the house is here more generally in use than at other places visited. For a house occupied during a few of the warm months each year only there seems to be no valid objection to the introduction of this arrangement of plumbing, even in the cold climate of Mount Desert, and it possesses a very decided advantage, where the work is of doubtful quality, in being largely out of doors; hence less liable to injuriously affect inmates. Bar Harbor is very like a rapidly-growing western town, and the surround-

ings of some of the houses are sometimes left in very primitive condition. Instances of this are indicated in the two plates shown, made from photographs, altered slightly to avoid too personal an application.

Plate No. 1 shows the back of a hotel accommodating 125 people; two lines of soil pipe, and a bath-room waste and house leader (all on the outside of the house), which deliver into a vitrified pipe laid on the surface of the ground. This pipe runs parallel with and close to the side wall of the building, and in the foreground of the picture is just under the plank at the right. The kitchen, at the left, connects with vitrified drain by a lead pipe near the kitchen steps. This pipe is perhaps 2 or 3 inches under ground. It is not unusual for market wagons to drive between the two buildings, and the vitrified pipe has been more than once broken at the joints by contact with the wheels of a vehicle.

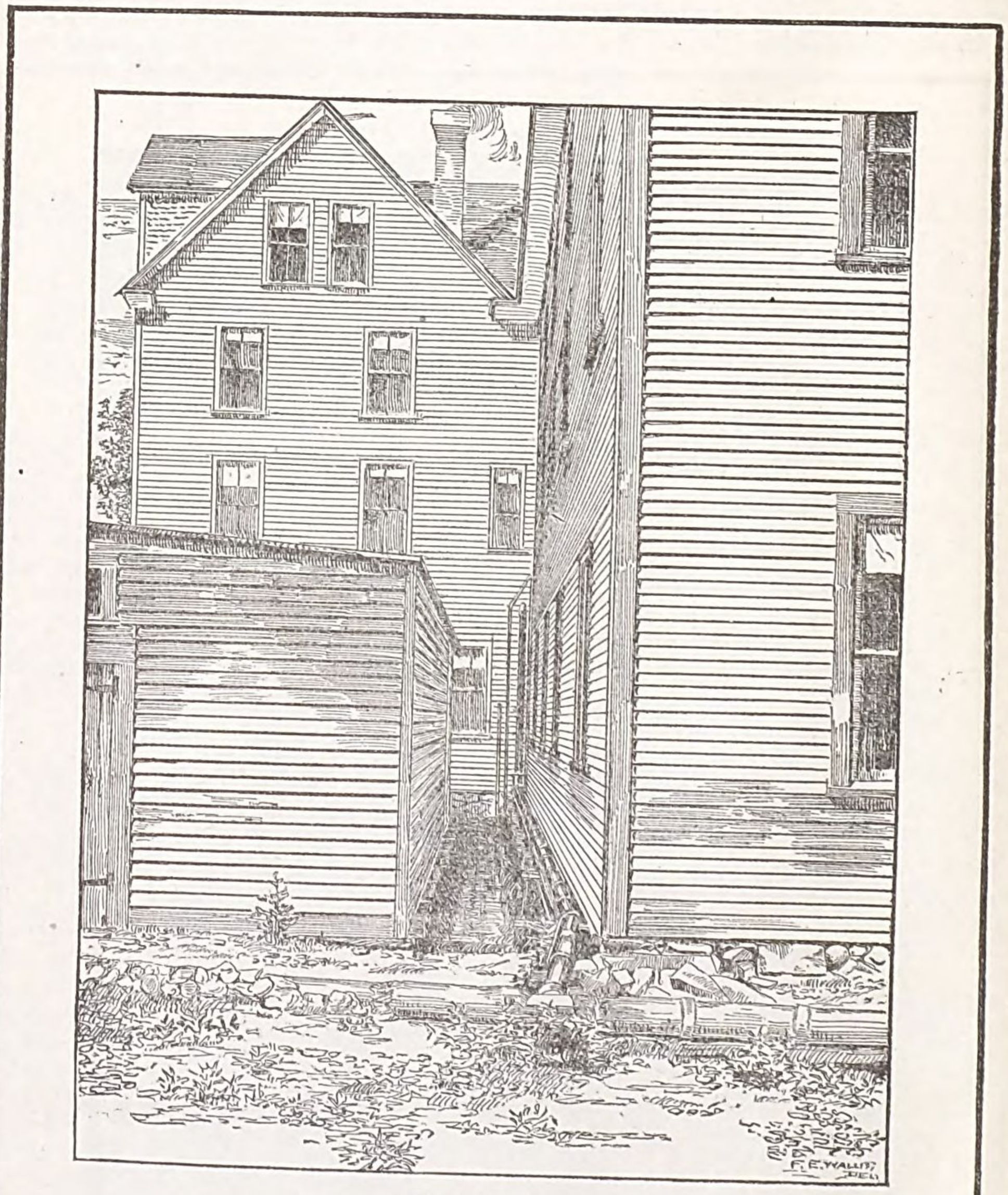


PLATE 2

Plate No. 2 represents the same general arrangement, except that the drain pipe is supported on a plank, and the ground water (within 18 inches of surface) has not been drained off. The main drain consists, not of vitrified pipe alone, but of vitrified cement and iron pipes, patched together in an inexcusable way. This pipe has also been broken a number of times by teams striking it. The proprietor of the house stated (it has since been corroborated by fact) that he considered his outside arrangements of only a temporary character, and that they were put up in a great hurry in order to be able to open the house for the season.

A local board of health of three members was organized in 1880, and, although an excellent beginning has been made, a few further changes might be instituted to good advantage. Garbage is regularly removed by scow and dumped in deep water in Frenchman's Bay, and people are forbidden to throw it in the streets, as was formerly done. The collection might be better made in water-tight carts, but at present everyone attends to their own carting. All nuisances are abated, &c.

A rather unusual nuisance, which has recently been abated at Bar Harbor, is a settlement of Quoddy Indians, comprising some seventy-five families, who camp during the summer months as near the village as possible, selling baskets, &c., to visitors. In the past they have been a positive source of danger, owing to their filthy habits, but after an experience of several fatal cases of diphtheria and a consequent scare among the summer guests the Indian colony was put under the charge of the board of health, with excellent results.

The resident population of Bar Harbor is not over 1250 souls, and the hotel accommodations are not for so large a number as is generally supposed. In the middle of the season there may be 5,000 guests—not more, though it is the custom to entertain four or five different sets of visitors during the season.

It would be a large estimate, however, to claim that there were 20,000 guests at Bar Harbor during any season. Undoubtedly the shortness of the visits made is an element to be considered in the freedom of the visitants from preventable disease, although a consideration of this kind should not abate one jot all sanitary precaution possible, since it is well, even from the narrowest possible commercial view, to establish the health of this favorite resort as best beyond all question.

Summer resorts, when first started, naturally depend upon either well or cistern water for drinking and cooking supplies. As a settlement grows, the well water, unless artesian, deteriorates in quality. As soon as this pollution begins, other water should be used, and as it is frequently impossible to obtain a public supply, cistern water of necessity is made use of.

Rain water, at least, must be pure, is the saying; and so it is, if properly collected and stored. As many people use cistern water, to the exclusion of all other, a list of memoranda taken from the field-notes of a single season's work may prove of service to readers.

Cisterns have been examined, mostly for cause, and many found to contain impure water. The different causes for the contamination, arranged according to the frequency of their occurrence, are as follows:

1st. Rotten shingles, leaves, hair, roots of trees, string, paint, putty, paper, &c.

2d. Thin, improperly built, brick walls, badly constructed inflows, and leakage from drains and cesspools. (Many brick cisterns, arched, and covered with loam and sod, show arches and walls, above inlets, not perfectly tight. Manure used as top dressing on the grass overhead not infrequently soaks through.)

3d. Excrement of birds on the roof from which the water is drawn.

4th. Chamber slops thrown on the roof, and thence passing direct to the cistern.

5th. Overflow emptying into cesspool or drain, and receiving gas or liquid from the same on account of partial or total stoppage of drain or filling of cesspool.

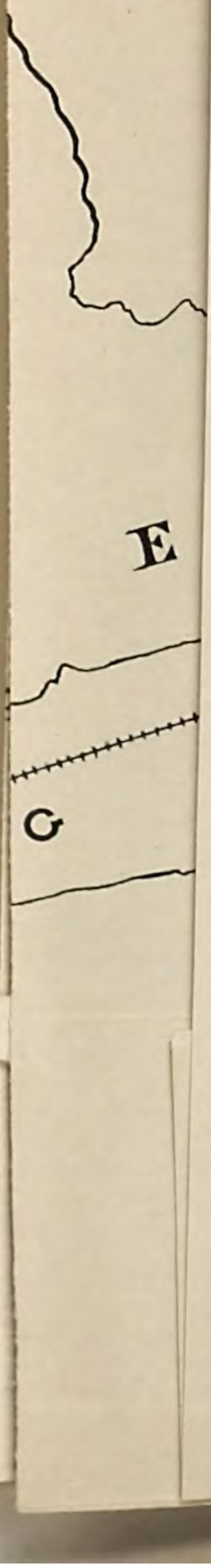
6th. Walls, partially constructed of brick, formerly used in old privy vaults.

With the exception of No. 3, the causes of pollution enumerated are all preventable, and within the grasp of the proprietor. Not so, however, frequently with wells and sometimes with public water supplies, and where any doubt exists as to the quality of the drinking water it may be stated in general terms that rain water collected from a clean roof, slated preferred, passing through metal gutters and leaders, into a carefully built, cement-lined cistern (having overflow connecting with no other drain), and then through a 2-inch brick filter, should give a very fair quality of water, fouled, perhaps, to a slight degree by the chimney flues and birds, and possibly a trifle hard, but usually not enough to constitute a valid objection to its use. This, of course, applies to country houses only.

In construction, the acknowledged fact of the porosity of all brick and cement work, no matter how carefully put together, is frequently lost sight of; hence, many of the cisterns, when empty, or partially so, have a tendency to attract water from the outside.

It is obvious that years of steady, intelligent work must elapse before summer hotels are sanitarily what they ought to be, and probably still longer before private houses can be considered wholly satisfactory; but if the resorts visited represent a fair average, there is good ground for hoping that the efforts of local boards of health will speedily produce good results of a tangible nature.

It is worthy of mention that with the single exception of Newport, where the existing condition of things may be considered abnormal, local boards of health have proved of decided advantage, always to the comfort, and frequently to the pecuniary well being, of the communities they serve.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APPENDIX D.

1. PRELIMINARY REPORT ON THE RESULTS OF AN INVESTIGATION, MADE BY DIRECTION OF THE NATIONAL BOARD OF HEALTH, AS TO THE CHEMICAL METHODS IN USE FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

2. REPORT ON THE RESULTS OF AN INVESTIGATION AS TO THE CHEMICAL METHODS IN USE FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

3. REPORT ON THE RESULTS OF A SUPPLEMENTARY INVESTIGATION AS TO THE CHEMICAL METHODS FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

By Prof. J. W. MALLET, F. R. S., University of Virginia.

PRELIMINARY REPORT ON THE RESULTS OF AN INVESTIGATION, MADE BY DIRECTION OF THE NATIONAL BOARD OF HEALTH, AS TO THE CHEMICAL METHODS IN USE FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

This research was undertaken in compliance with the instructions of a letter from the president of the National Board of Health, written on behalf of the executive committee of the Board, and dated Washington, December 29, 1880.

A full report on the objects, in detail, of the investigation, on the methods employed, and the results obtained, has been prepared and placed in the hands of the Board. Pending its publication *in extenso*, the executive committee has thought proper to direct that an abstract, covering the principal conclusions reached, should be published in the Bulletin. The following pages present such an abstract:

It was intended to examine carefully the chief processes in use for chemically determining the organic matter, or its constituents, in drinking water, to test the absolute and relative accuracy of the results these processes are capable of yielding, and, as far as possible, to ascertain the nature and scope of the practical conclusions available for sanitary purposes which may thence be secured.

Three chemists took charge severally of the so-called "combustion process" of Frankland and Armstrong, the "albuminoid-ammonia process" of Wanklyn, Chapman, and Smith, and the "permanganate process" originally suggested by Forchhammer, in the form advocated and minutely described by Tidy. These gentlemen, Mr. W. A. Noyes, Dr. Charles Smart, U. S. A., and Dr. J. A. Tanner, U. S. N., worked independently, the first in the laboratory of the Johns Hopkins University, at Baltimore, by permission of its authorities, the second at the office of the National Board of Health, in Washington, and the third in the laboratory of the University of Virginia. Arrangements were made to have the samples of water for examination collected and distributed to these three points by myself, so that there should be identity of material submitted to each analyst, and all three analysts should examine their several samples on the same day. Prof. H. Newell Martin, of the Johns Hopkins University, kindly undertook a simultaneous microscopic examination of the waters placed in the hands of the chemists, as also a series of pathological observations on the effect of injecting the waters, concentrated by evaporation at very low temperature, beneath the skin of rabbits, whose temperature and general condition were compared with those of like animals not so treated.

A large amount of preliminary and special work was done in the early part of 1881, the former chiefly with a view to making the analysts thoroughly familiar with the processes to be tested before coming to the actual tests themselves, the latter on various modifications of the processes in detail, and incidental points in connection with them of sanitary interest. From this work a number of results of considerable interest have been obtained, but their publication will have to be made in their place in the general report.

For the main series of test analyses, the following classes of waters were obtained or prepared:

CLASS I.—Natural waters, believed from actual use to be of good, wholesome character, including the regular water supply of some of the principal cities of the United States.

CLASS II.—Natural waters which there seems to be fair ground for believing have actually caused disease on the part of those drinking them. A request for information as to such waters, and for samples of them, was published for several months in the National Board of Health Bulletin, and was extensively copied into newspapers and professional journals, and a copious correspondence with physicians and others in various parts of the country was employed to secure such samples, and to sift the evidence as to the supposed connection of the use of each water with the production of disease.

CLASS III.—Natural waters, of doubtful, but more or less suspected, character. In reference to these the medical evidence was insufficient to justify placing them in Class II.

Class IV.—Artificially prepared waters, made by adding to good, wholesome water, determinate amounts of various infusions of *vegetable* organic matter, of natural origin, and of such kinds chiefly as water for human consumption is liable to be brought in contact with.

CLASS V.—Artificially prepared waters, made as above, with various forms of *vegetable* refuse from manufacturing or industrial operations.

CLASS VI.—Artificially prepared waters, as above, made with *animal* (or partly animal) organic matters of natural origin, especially such as are likely to occur in connection with the contamination of drinking-water.

CLASS VII.—Artificially prepared waters, as above, made with *animal* refuse from manufacturing or industrial operations.

CLASS VIII.—Artificially prepared waters, as above, to which had been added morbid products from certain diseases in the human subject.

CLASS IX.—Solutions, in distilled water, of carefully determined amounts of pure substances of definite chemical composition.

The results obtained from the examination of a large number of samples, representing the above classes of waters, are given in detail in a table in the general report. At present the conclusions reached in the discussion of these results can alone be given.

GENERAL DISCUSSION OF RESULTS.

Degree of accuracy of the three principal processes examined.—This may be looked at in two ways: first, as to the concordance of the results obtained by each process in duplicate or triplicate experiments on the same water; and, secondly, as to the agreement of the results obtained with the actual contents of a particular water when these are quantitatively known.

In the former of these aspects we have to do with such errors as are, practically speaking, fortuitous; in the latter we notice especially the indications of constant errors inherent in the methods used.

Extent of concordance of the results obtained by each process in multiplied experiments on the same water.—This has been tested by taking the mean of duplicate or triplicate determinations, noting the difference between this mean and each of the individual determinations on which it was based, and calculating this difference as percentage on the mean itself. The data for such calculation have been most numerous in the case of the combustion process, since it was considered necessary to make duplicate analyses all through the research, with a number of triplicates. It is the more important that this process should be thus examined, in view of the objection which has been often made to it, that it demands an unusual degree of skill and training on the part of the experimenters. In connection with the extensive work of the English Commission on the Pollution of Rivers, it is to be supposed that many duplicate analyses must have been made by this method, but there has appeared but little in print to show how far these were concordant. The results obtained in the course of the present research are summarized in Tables XI, XII, and XIII.

TABLE XI.—*Extent of disagreement of results of multiplied analyses of same water by combustion process.*

	Divergence of individual results from mean, *as percentage on mean.*		
	Greatest.	Least.	Average.
For all waters in Classes I to VIII, inclusive, save the few for which there was but one analysis, and those for which there was a known source of error vitiating one of the analyses:*			
Organic carbon	†24.46	0	4.24
Ditto, rejecting twelve cases in which the divergence was over 10 per cent. (ten of these cases involved very minute absolute quantities of carbon)	9.96	0	2.89
Organic nitrogen	‡40.00	0	9.48
Ditto, rejecting thirteen cases in which the divergence was over 20 per cent. (ten of these cases involved very minute absolute quantities of nitrogen)	19.82	0	7.09
For the waters in Class IX (solutions of definite chemical substances in known amount):§			
Organic carbon	‖50.00	.15	9.54
Ditto, rejecting six cases in which the divergence was over 10 per cent. (four of these cases involved very minute absolute quantities of carbon)	7.76	.15	2.81
Organic nitrogen	¶14.52	0	5.05
Ditto, rejecting five cases in which the divergence was over 10 per cent. (but one of these cases involved a very minute quantity of nitrogen)	9.75	0	2.71
Average of both the above sets of experiments, giving them equal weight:			
Organic carbon (including all cases)	37.23	.07	6.89
Ditto (rejecting in all thirty-six extreme cases, as above)	8.86	.07	2.85
Organic nitrogen (including all cases)	27.26	0	7.26
Ditto (rejecting in all thirty-six extreme cases, as above)	14.78	0	4.90

* Representing in all two hundred and sixty-two separate analyses for carbon and two hundred and forty-six for nitrogen. (Some analyses for the latter element were vitiated by uncertainty in the determination of free ammonia, and hence in the amount to be subtracted for this latter.)

† Actual difference was less than .3 milligram.

‡ Actual difference was only .04 milligram.

§ Representing in all forty-one separate analyses, each for carbon and nitrogen. (One determination for each was without a duplicate, and hence had to be rejected from the data for this table.)

‖ Actual difference was .035 milligram.

¶ Actual difference was .47 milligram.

TABLE XII.—*Extent of disagreement of results of multiplied experiments on same water by albuminoid-ammonia process.*

	Divergence of individual results from mean, *as percentage on mean.*		
	Greatest	Least.	Average.
For thirteen waters in Classes I to VIII, examined in triplicate:*			
Free ammonia	36.05	0	5.91
Ditto, rejecting two cases involving very minute quantities of free NH_3	19.05	0	2.79
Albuminoid ammonia	8.51	0	2.69
For waters of Class IX (twenty-one in all—all examined in duplicate):†			
Free ammonia	5.53	0	1.67
Albuminoid ammonia	14.28	0	6.19
Ditto, rejecting four cases involving very minute quantities of alb. NH_3	12.79	0	4.56
Average of both the above sets of experiments, giving them equal weight:			
Free ammonia (including all cases)	20.79	0	3.79
Ditto (rejecting two extreme cases as above)	12.29	0	2.23
Albuminoid ammonia (including all cases)	11.39	0	4.44
Ditto (rejecting four extreme cases, as above)	10.65	0	3.62

* Representing thirty-nine separate determinations.

† Representing forty-two separate determinations; of course purely negative results are not included in the data for this table.

TABLE XIII.—*Extent of disagreement of results of multiplied experiments on same water by the permanganate process.*

	Divergence of individual results from mean, *as percentage on mean.*		
	Greatest.	Least.	Average.
For twelve waters in Classes I to VIII, examined in duplicate:*			
Oxygen consumed in one hour†	4.70	0	1.09
Oxygen consumed in three hours‡	4.35	0	.56
For waters of Class IX (twenty-one in all, all examined in duplicate) §:			
Oxygen consumed in one hour‖	8.33	0	.62
Oxygen consumed in three hours¶	6.66	0	1.10
Average of both the above sets of experiments, giving them equal weight:			
Oxygen consumed in one hour	6.51	0	.85
Oxygen consumed in three hours	5.50	0	.83

* Representing twenty-four separate determinations.

† Including five cases in which divergence was over 1 per cent. (in all these but very little oxygen was consumed).

‡ Including two cases in which divergence was over 1 per cent. (in these very little oxygen was consumed).

§ Representing forty-two separate determinations. Of course those are not included in the data for this table, which showed no oxygen, or but a mere trace, consumed.

‖ Including one case in which divergence was over 1 per cent. (very little oxygen consumed).

¶ Including three cases in which divergence was over 1 per cent. (very little oxygen consumed).

Of the figures given in the last column of Table XI, those which probably represent with most fairness the average departure from the mean of an individual determination by the combustion process* are:

	Per cent.
For organic carbon	2.89
For organic nitrogen	7.09

This goes in part to support the opinion of Tidy† that the results of the combustion process are less to be relied on for nitrogen than for carbon.

The results shown for the waters of Class IX are less deserving of attention in this particular respect, since there were but seven different organic substances included, and these specially selected. The reversal of position of the carbon and nitrogen results in this class as compared with the preceding, is partly due to great and variable loss by evaporation of the volatile organic acids, and by dissociation of the salts of the amines, &c.

From the last column of Table XII, the figures which probably may most fairly be taken to represent the average divergence from the mean of a single determination by the albuminoid-ammonia process are:

	Per cent.
For free ammonia	2.23
For albuminoid ammonia	3.62

We should naturally expect to find greater irregularity in the evolution of the so-called albuminoid ammonia, though the conditions of chemical action be made as nearly as possible the same.

As regards the averages in the last column of Table XIII, the consumption of oxygen by the waters in Class IX having been for the most part very small, it seems probable that, for practical purposes, the first figures may best be taken, viz:

	Per cent.
For oxygen consumed in one hour	1.09
For oxygen consumed in three hours	.56

showing somewhat greater irregularity in the early stage of the action than later.

It will be seen that on the whole the most closely concordant results were furnished by the permanganate process, and the least so by the combustion process, the albuminoid-ammonia process holding the intermediate position.

Extent of agreement of the results obtained by the different processes with the quantities of organic constituents known to be actually present.—The detailed evidence under this head is given in columns 19 to 25, inclusive, of the last sheet of Table X, in which the e-

* See Mills's conclusions from a much more limited basis of induction furnished by a few of Frankland's analyses.—Jour. Chem. Soc. (Lond.), February, 1878; 58 *et seq.*

† Jour. Chem. Soc. (Lond.), January, 1879; 56.

sults actually obtained on examination of the waters in Class IX (solutions of known amounts of certain organic substances of definite chemical composition) are compared with the amounts of the organic elements really present, and the calculated amounts of oxygen required for their complete oxidation.* The following summary (in Table XIV) presents the conclusions reached within the limits of these experiments.

TABLE XIV.—*Extent of agreement of results obtained by the different processes with the known chemical character of the waters in Class IX.*

	Amounts obtained, as percentage upon amounts calculated.		
	Greatest.	Least.	Average.
Combustion process:			
Organic carbon	85.	1.	53.
Organic nitrogen (including that of ammonia)	180.	47.	118.
Albuminoid-ammonia process:			
	Greatest.	Least.	Average.
Nitrogen of free NH_3*	94.	0.	(28.)†
Nitrogen of alb. NH_3*	84.	0.	(24.)†
	95.	0	53.
Permanganate process:			
Oxygen consumed in one hour	13.	0	3.
Oxygen consumed in three hours	16.	0	4.

(In this table, as in the last sheet of Table X, a considerable fraction of 1 per cent. is represented by 1—; an insignificant fraction is considered=0.)

* Both calculated as percentage on *total* nitrogen present.

† These two averages have no real significance.

The figures of this table strikingly indicate certain important defects of the several processes, although they must be looked at in a broad, general way, remembering the small number of organic substances treated, and their special characters.

As regards the combustion process, we find loss of carbon, in all cases considerable, and in some cases very great; with a strong tendency on the whole to excess of nitrogen, which in some cases is very great. It is of course easy to see how, in large measure at least, these errors were caused for some of the samples. Thus doubtless, free butyric and valerianic acids were formed from their salts, and volatilized with the water during its evaporation; the salts of the amines probably suffered partial dissociation, with volatilization of the bases; and urea was lost after conversion into ammonium carbonate. It may be objected that such substances as these ought not to have been selected. But it is to be remembered that every one of them occurs among the products of putrefactive decay of albuminoid or other organic matter, and hence may fairly be looked for among the constituents of organically polluted water.†

The occurrence of loss of organic constituents during the evaporation of water for the combustion process has often been suspected by the critics of that process,‡ and often, though sometimes cautiously, denied by its advocates. Thus Mills has said§:

"Substantially satisfactory evidence has been adduced that there is no material loss during the evaporation. The experiments now reported prove exactly the reverse of this and furnish for the first time, as far as I know, direct evidence of the fact that, for some organic substances at least, and those of a kind liable to occur among the products of putrefaction, there *is* material, nay very great, loss.

As regards the frequently presented excess of nitrogen, I am strongly inclined to believe it in part at least due to absorption, during the evaporation of the acidified water, of ammonia *from the atmosphere surrounding the gas flame* and water-bath. Due care was taken as to the general condition of the atmosphere of the room, and it hardly seems possible to account for the error from this source.‖ But any one who has

* In this calculation hydrogen has been taken as converted into water, carbon into carbon dioxide, and nitrogen as evolved in uncombined form; of course no one would expect any such ultimate results of oxidation from the action of the permanganate as practically applied. Frankland, in a similar calculation (Jour. Chem. Soc. (Lond.), March, 1868; 83), seems to have taken the nitrogen as oxidized to nitric acid.

† Fresenius and Scherer have found butyric and propionic acids in the mineral water of Brückenau and Weilbach. Zeitschrift für anal. Chem., 20; 3; 325.

‡ Wanklyn asserts in the most positive way the occurrence of loss, but gives no experimental evidence in support of his assertion. (Water Analysis, London, 1879; 190.)

§ Jour. Chem. Soc. (Lond.), February, 1878; 58.

‖ The most scrupulous pains, too, were taken to guard against leakage of air into the Sprengel vacuum and nitrogen from the cupric oxide, and errors from these sources could scarcely have failed to be detected. They were examined into over and over again.

noticed the considerable deposit of ammonium sulphate formed on platinum vessels over an ordinary laboratory lamp, or on bells suspended over household gaslights, will readily admit that here is a manifest source of danger. The extent to which ammonia is removed from coal gas at different works, and in the same works at different times, varies no doubt a good deal, but all American gas which I have examined readily shows its presence. With the gas in use at the University of Virginia and the neighboring town of Charlottesville, I find that when not ignited it will in five seconds produce a distinct yellow stain on a drop of the Nessler reagent upon white filtering paper, and, although no doubt much ammonia undergoes combustion when the coal gas itself is burning, a platinum capsule of 3 inches in diameter, containing water to keep it cool, will, if held over the flame of a Bunsen burner for half a minute, and the outside surface then washed off into a test glass, yield a liquid which distinctly gives the Nessler reaction for ammonia. During the many hours of the evaporation of a water sample there must occur in the atmosphere about the water-bath a quantity of nitrogen in the form of ammonia which may well be called very large in comparison with the amounts dealt with by the water analyst, and although contact of the contents of the glass dish with this atmosphere is largely cut off by the glass shade, such contact is not entirely prevented, as there is the notch in the rim of the water-bath for the passage of the feed-flask neck. The avidity with which such ammonia as may reach the acid water will be absorbed by it is obvious enough, even though some be afterwards lost by dissociation. The excess of nitrogen observed in the analyses of Class IX seems to be general; even in those cases in which a loss is recorded it will be noticed that this loss is always less than for the carbon of the same substance, and the result is most probably a mere balance between two errors in opposite directions, actual loss of organic nitrogen volatilized in some form during the evaporation of the water, very possibly to even a greater extent than for carbon, and on the other hand absorption of nitrogen as ammonia from the atmosphere.

In reference to the results obtained by the albuminoid-ammonia process, little more is presented than has already been fully discussed in an earlier part of the general report. The total loss of the amine bases by volatilization during the first distillation (with sodium carbonate) results practically, as these bases do not produce the ammonia color with the Nessler reagent, in their nitrogen escaping recognition under the head of either "free" or "albuminoid" ammonia. Here we have a proof that some, at least, of the nitrogenous products of putrefaction are not detected or determined by this process as usually conducted.* There is no discrepancy between the results as to these bases here noticed, and that recorded for a triethylamine salt in Table VII of the general report; in this last mentioned case the salt was in contact with alkaline permanganate from the commencement of the distillation.

The results in this Class IX by the permanganate process have mainly the same sort of interest. It has, of course, long been known that, in the words of Tidy,† "there are many substances (most of which are crystalline) that are altogether unacted upon, or very slowly acted upon, by the oxygen of permanganate"; but it has been distinctly claimed for this process‡ by the same chemist that "it undoubtedly furnishes us with exact information as to the relative quantities of putrescent and easily oxidizable matter, and of non-putrescent or less easily oxidizable matters, present in the water. The former (viz, the putrescent organic matters) it indicates quantitatively with great accuracy; the latter (viz, the non-putrescent matters) are scarcely capable of the same exact estimation as the former, for they are bodies for the most part of difficult oxidation." Now here we have some of the definite substances which are actually known to occur among the constituents of putrescent albuminoid matter, and it needs but a glance at the table to see how limited is their oxidation by the cold acid permanganate, and yet how considerable are the differences in behavior of these few substances selected mainly on the same general principle.

Of course it is not assumed that the figures in Table XIV really represent either the range of absolute error, or the average amount of absolute error, of the different processes as applied to the doubtless very various forms of organic matter liable to occur in natural waters; these figures do, however, illustrate the existence of sources of absolute error, and by examples taken from the very class of substances which it has been most commonly believed important to detect and determine in water analysis.

Effect on the results by the different processes of varying the extent of dilution of the same organic substances in water.—The evidence in regard to this point is graphically presented in Tables XV, XVI, and XVII.

(These tables will appear with the general report.)

In studying these tables, indications of definite effects on the results of the various processes arising from the degree of dilution of the liquids examined soon become ap-

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*Wanklyn has excepted nitro-compounds and (erroneously) urea, but clearly implies that these are the only exceptions; that the nitro-compounds are without practical importance, and that urea is specially provided for. Water Analysis, London, 1879; 189.

†Jour. Chem. Soc. (Lond.) Jan., 1879; 78.

‡Loc. cit., 80.

parent, but seem to be subject to much irregularity. Such irregularity, however, is much reduced by a careful consideration of all the circumstances affecting individual cases. Thus, some of the numerical results of analysis ought to be omitted from consideration as vitiated by known errors, as in the case of albuminoid ammonia determinations in obtaining which the whole of the alkaline permanganate was reduced, or an obviously considerable part of the ammonia was still coming off when the process had to be stopped. In other cases the value of the results is rendered doubtful by the solution examined having been excessively dilute or excessively strong; the relatively greater analytical errors for the former, and for the latter the errors of measurement of very small quantities of the liquid itself and greater uncertainty as to its uniformity when turbid, tend to make the figures obtained less trustworthy than when intermediate degrees of concentration were involved; Nos. 110 to 118 inclusive represent the former source of abnormal results, such waters as No. 100 the latter. Again, the three solutions containing each form of polluting material in different degrees of dilution were, as has been explained, necessarily examined on different days, and evidence of changes going on in the mean time are to be found in the relative amounts of free and albuminoid ammonia, the character of the dissolved gases, &c. (see for the latter Nos. 83, 84, 85); hence the *order* in which the three solutions of each group were examined has to be taken into account. Further, the results of one of these tables have often to be considered in their bearing on those of the others, as, for instance, the free ammonia determinations as affecting the value of the figures for organic nitrogen. And, lastly, after having observed the general drift of the errors indicated, we can see in the varying balance of errors of opposite effect an explanation of many apparently exceptional figures.

The general results of such detailed study of individual cases agree with those obtained by a simple calculation of averages, omitting from the calculation such figures as on sound grounds of general principle are to be regarded as vitiated for the purpose of this discussion. In the following table the solutions of the seven pure chemicals (Nos. 141 to 161) have been left out on account of the abnormal relations of these (which have been separately discussed) to some of the processes. For the combustion process, two other substances, represented by the dilutions Nos. 101 to 103, and 122 to 124, are omitted, because in the former of these the figures for organic carbon are known to be of very little value, and those for organic nitrogen are entirely valueless in consequence of the uncertain determinations of free ammonia present in large quantity (which had to be subtracted from the gross results of analysis), while in the latter the very large amount of the free ammonia correction makes the results doubtful. For the albuminoid ammonia process, those determinations of free ammonia originally marked by Dr. Smart as uncertain (by a ?) have been omitted, and those determinations of albuminoid ammonia, in making which the regular charge of alkaline permanganate was entirely reduced, requiring an additional charge to be afterwards added, or dilution to be resorted to. For the Kubel form of the permanganate process one or two cases have been omitted, in which the permanganate was entirely reduced, making the result valueless save as an approximation. Rejecting these obviously worthless data, the averages from all others are given in Table XVIII.

TABLE XVIII.—*Average results obtained for different dilutions of same solution of organic matter.*

	One-fifth per cent. strength.		One per cent. strength.	Five per cent. strength.	
	Calculated.	Obtained.	Assumed.	Calculated.	Obtained.
Combustion process:					
Organic carbon	20.	17.5	100.	500.	549.8
Organic nitrogen	20.	25.2	100.	500.	372.2
Albuminoid-ammonia process:					
Free ammonia	20.	39.9	100.	500.	445.3
Albuminoid ammonia	20.	27.2	100.	500.	257.9
Permanganate process:					
Tidy method—					
Oxygen consumed in one hour	20.	19.7	100.	500.	475.0
Oxygen consumed in three hours	20.	20.0	100.	500.	468.9
Kubel method—					
Oxygen consumed	20.	19.9	100.	500.	475.9

As regards the combustion process, we find distinct confirmation of the existence of the two forms of constant error which have been pointed out as affecting the evaporation.* The weaker the solution, or, in other words, the larger the quantity of water to be evaporated for a given amount of organic matter, the less is the amount of organic carbon obtained, indicating relatively greater loss of this element. On the contrary, the weaker the solution or the greater the quantity of water to be evaporated, the larger is the figure for organic nitrogen, indicating relatively greater gain of this element from the atmosphere, and probably in some cases less dissociation of ammoniacal salts, when the amount of free ammonia found is considerable. If the usual interpretation of Frankland's C : N ratio be applied, the curious and important result of these sources of error, affecting the two elements in opposite directions, follows, that the more dilute an organically polluted water is, the more animal-like in origin will its polluting material seem to be, while the stronger it is the greater will be the tendency to refer the contamination to a vegetable source; this distortion of the conclusions to be drawn from an examination by the combustion process is manifestly in the opposite direction to that commonly assumed to be safe.

In reference to the albuminoid-ammonia process, the weaker the solutions are, the higher are the results obtained, both for free and albuminoid ammonia,† the influence common to both being probably that of imperfect condensation in the distillation, having a less effect as the quantity of ammonia is smaller. As for the albuminoid-ammonia, the lower results obtained from the stronger solutions may be partly due to the smaller proportion borne by the fixed charge of alkaline permanganate to the quantity of organic matter to be acted on. The great irregularity in individual analyses is strongly indicative of a varying balance of errors from different sources. It will be observed that the discrepancy between the calculated figures and those of experiment is greatest for free ammonia in the case of the weakest dilution, while the reverse is true for albuminoid ammonia.

The results of the permanganate process are shown to be much less influenced by varying dilution within the limits involved in these experiments than those of the other processes. In the case of the solutions of greatest strength somewhat smaller figures are obtained for the oxygen consumed than calculation calls for.‡ This is probably due to the fact that for the weaker waters the ordinary fixed charge of permanganate added at the first leaves at the close of the process a relatively larger excess than is present when successive additions of the reagent have been made to a water strong enough to reduce the first charge completely.

We must not confound the effect of varying the amount of organic matter in relation to the permanganate by which it is to be oxidized with that of varying greatly, but to the same extent, the degree of dilution of both organic matter and permanganate at the same time. Dr. Tanner's experiments showed that under the latter head a solution of even potassium nitrite might be made so dilute that its action on a correspondingly small quantity of permanganate was rendered very slow.

It may, perhaps, be said in reference to all these experiments on varied dilutions of the same materials, that the several processes under examination are intended for use on water of approximately suitable character for drinking, not on comparatively strong solutions of organic matter, such as many of those I have employed; but the answer to this objection is, that these liquids were taken in order to *exaggerate*, and hence bring to light any defects inherent in the several processes, so far as such depend upon the simple condition of the amount of polluting material in proportion to that of pure water.

SPECIAL CONCLUSIONS AS TO THE COMBUSTION PROCESS.

These may be briefly stated as follows:

1. The combustion itself, carried out according to the directions of Frankland, is a process of great delicacy, and quite satisfactory in its details with proper precautions and in trained hands. There seems to be no advantage in employing any of the various modified ways of determining the gaseous products of combustion which have been proposed instead of gaseous volumetric analysis with the aid of the Sprengel vacuum.

2. The Frankland process is quite within the reach of the manipulative skill of any fairly-trained chemist, but it requires practice, and probably pretty constant practice. It cannot be taken up off-hand, and even tolerable results obtained at once.

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* Compare the results observed by Mills (Jour. Chem. Soc. (Lond.) Feb., 1878; 60) in using evaporating dishes of different diameters. The larger dish gave a rather lower result for carbon, and higher for nitrogen.

† This agrees with Dr. Smart's single experiment on Washington sewage in its original form and diluted. See "remarks" on No. 116 in Table X of general report.

‡ Some indications of a like result may be noticed in a few experiments of Tidy (Jour. Chem. Soc. (Lond.), January, 1879; 80, 81), though the variation in strength of his solutions was not so great, and he himself draws the conclusion that the consumption of oxygen was proportional to the strength.

From the hands of a person without proper laboratory training, its results are utterly valueless. It is hence better adapted to regular use in the examination of many samples of water in a large public laboratory than to occasional use by a private individual in now and then examining a single water.

3. The defective point in the process is the failure of the evaporation to leave a residue representing the original organic matter of the water. This, which has been hitherto more or less suspected, has been established as a fact by the investigation now reported on. The process being conducted according to the directions of its authors, there are two constantly-present errors, varying, but usually important in amount, namely loss of carbon,* and gain of nitrogen from the atmosphere, the latter probably partly balanced by loss of that originally present in the water. These errors are relatively greatest when the quantity of organic matter in the water is small.

4. These errors, affecting unequally the carbon and nitrogen, are liable to alter the statement of C : N ratio,† and hence to distort the sanitary conclusions usually drawn therefrom.

5. The result for organic nitrogen, as obtained by the combustion process, is also affected indirectly by the errors connected with the determination of the ammonia ("free ammonia"), as the nitrogen belonging to this has to be subtracted from the gross result. The existence of such errors, as from imperfect condensation of the ammonia, progressive decomposition of urea and other amides, &c., has been pointed out in previous pages of this report, and will be referred to in the conclusions as to the albuminoid-ammonia process.

6. There is a further indirectly operative cause of error as to the nitrogen, arising from the varying loss of ammonia by dissociation of its salts during the evaporation of the water. Frankland recognizes the necessity of a correction for this, which correction he makes depend upon the amount of ammoniacal salts present, but it is almost certain that the time occupied in the evaporation will also influence the extent of loss by dissociation. Error from this source will in most cases be very small, but may affect to a not unimportant extent the result for *organic* nitrogen.‡

7. The combustion process involves special difficulties in the presence of nitrates, for which difficulties no completely satisfactory remedy is as yet proved to have been found. M. W. Williams' mode of applying the copper-zinc couple for this purpose is deserving of more precise quantitative examination than it has yet received. The simultaneous presence in a polluted water of urea with nitrites and nitrates presents a case of peculiar difficulty involving several sources of error.

8. The formation of sulphuric acid during the evaporation of the water with sulphurous acid seems to be of more frequent occurrence than has hitherto been recognized. Mr. Noyes seems to think that to this source—small amounts of cupric sulphate being formed on mixture of the residue with cupric oxide—may perhaps be attributed the occasional presence, as noticed by Frankland, of traces of free oxygen among the gaseous products of combustion. This occurrence of sulphuric acid in the water residue, even in minute amount, is undoubtedly much to be deprecated, though its effect at any rate on the carbon determinations has not seemed to be as great as might have been expected.

9. The combustion process in its present form cannot be considered as "determining" the carbon and nitrogen of the organic matter in water in a sense to justify the claim of "absolute" value for its results which has been denied to those of all other methods. It is but a method of approximation, involving sundry errors, and in part a balance of errors.

10. There is, however, good ground for believing that in many, perhaps most, cases its results for organic carbon may, with proper precautions, be made more valuable than the indications of the permanganate process, and its results for organic nitrogen in like manner more valuable than the indications of the albuminoid-ammonia process.

SPECIAL CONCLUSIONS AS TO THE ALBUMINOID-AMMONIA PROCESS.

These may be briefly summed up as follows:

1. In the determination of both "free" and "albuminoid" ammonia there is a loss, which may be quite considerable, resulting from imperfect condensation of the ammonia during distillation. This loss varies in amount with the precise conditions under

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* In connection with this a number of Dr. Smart's experiments are noteworthy, in which the distillate for free ammonia furnished evidence, by its haziness and greenish color, distinct from that which the Nessler reagent should have yielded, that volatile organic matter was present.

† In Prof. W. R. Nichols' Report on the Boston Water Supply (Fourth Annual Report of Boston Water Board, 1880), variations of the C : N ratio, extending from a given value to one, three, or three and a half times as great, are observable for the Cochituate water within a few weeks, and still greater variations for the Mystic water.

‡ Examples are furnished by Frankland of analyses in which the ammonia correction is very large in comparison with the organic nitrogen.

which the distillation is conducted, especially with the efficiency of the cooling apparatus and the time occupied in the process.

2. In the case of waters containing urea, and also other amidated bodies, such as the leucine and tyrosine occuring among the products of putrefactive decay, some ammonia is so easily formed from these substances by boiling with sodium carbonate, or even without this addition, that it is impossible to distinguish sharply between pre-existing "free" ammonia (of ammoniacal salts), and that formed by the action of alkaline permanganate, the so-called "albuminoid" ammonia. This source of error as to the free ammonia reacts, as has been noticed above, upon the result for organic nitrogen by the combustion process.

3. There is no satisfactory evidence in favor of Wanklyn's view that in distilling with alkaline permanganate, definite and simple fractions of the nitrogen of organic matter are given off as "albuminoid" ammonia. Such results may be varied at pleasure for most, if not for all, substances, by slight modification of the conditions under which the distillation is conducted.

4. If the distillation with alkaline permanganate be carried out as usual, in accordance with Wanklyn's instructions, it frequently happens that the nitrogenous organic matter is so gradually acted upon as to make the ending of the process indefinite; ammonia is still coming off when the distillation has to be stopped in consequence of the contents of the retort being nearly reduced to dryness. In such cases an unknown fraction of the possible amount of albuminoid ammonia fails to be collected, and is but vaguely indicated by the sign × after the figures recorded.

5. There is evidence that in some cases nitrogenous organic matter is volatilized during the distillation for free ammonia, which, if it had been retained, would have yielded up its nitrogen as albuminoid ammonia; not affecting the Nessler reagent, such nitrogenous matter escapes detection under either head.

6. The albuminoid-ammonia process proper, *i. e.*, the distillation with alkaline permanganate and determination of the ammonia evolved, is admittedly simply and easily carried out with very little preparatory training.

7. The value of the results by this process depends more upon watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

8. Taking the results by this process as recorded, we find a good deal of general similarity between the figures for albuminoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent, such as prevent the one being taken as the accurate measure of the other. See Tables XIX and XX, further on.

SPECIAL CONCLUSIONS AS TO THE PERMANGANATE PROCESS.

The chief points worthy of attention are the following:

1. The results obtained by the Tidy method (using the acidified permanganate at common temperature) and by that of Kubel (operating at the boiling point) differ irregularly from each other, the latter usually giving much higher figures, as was to be expected, but the ratio between the results by the two methods varies much in different cases.

2. On the whole, there seems usually to be a nearer approach to proportionality with the qantities of organic carbon* found by the combustion process on the part of the results afforded by the Kubel process than on that of the Tidy results, but to this there are some very notable exceptions. See, on this point, Tables XIX and XX, further on.

3. In a good many instances the results obtained by the Kubel method are, contrary to the general rule, lower than those afforded by the Tidy method. This seems to be due, in all probability, to loss of organic matter for volatilization with the escaping steam from the boiling liquid before time has been afforded for action on the permanganate.† An examination of all the results obtained for Nos. 131, 132, and 133, and several other cases, gives good ground for believing this to be the case. Of course, a similar loss may have occurred in other instances, but not to the extent of reversing the general rule as to the results by the Kubel process being larger than those by the

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*This appears to be the proper way of comparing the results of the permanganate with those of the combustion process. The former process is clearly concerned much more with carbon than nitrogen, if oxygen be usually at all consumed by nitrogen. It is not easy to admit the soundness of the logic with which Tidy (Jour. Chem. Soc. (Lond.), Jan., 1879, 94–97) points to the concordance of results, by the permanganate and combustion processes, and the disagreement with both these of the results by the albuminoid-ammonia process, and hence apparently infers that the two former are trustworthy, and the last not so. He uses the *sum of organic carbon and nitrogen* to represent the results by the combustion process, and as the carbon forms generally much the larger part of this, he naturally arrives at an agreement with the results of the process mainly depending on the oxidation of carbon, and disagreement with those of the process evolving nitrogen as ammonia.

†It is worthy of remark that the largest number of cases among natural waters of the Kubel process giving a lower result than that by the Tidy process occur among the waters believed to be *dangerous*, *i. e.*, Class II.

method of Tidy; and this may in part explain the absence of any uniform ratio between the figures yielded by those two modifications of the permanganate process.

4. The results attainable by the Tidy process are liable to variation with the atmospheric temperature prevailing at the time the process is applied.

5. The amount of oxygen consumed by a specimen of water is probably in all ordinary cases much below that required for complete oxidation of the organic matter present, and does not stand in any fixed ratio thereto; it cannot be taken as a measure either of the organic carbon or of the total organic matter. Nevertheless, a distinct general resemblance may be traced between strongly marked results, high or low, as the case may be, for the consumption of oxygen on the one hand, and organic carbon (by the combustion process) on the other; and closer agreement is observable in regard to waters of generally similar character.*

6. The permanganate process is capable of giving more valuable information in regard to a water by watching the *progress* and *rate* of the oxidation of organic matter present than by any single determination of the absolute amount of oxygen consumed in a given time.

7. For such observation of the progress of oxidation the two determinations prescribed by Tidy, viz, of oxygen consumed in one hour and in three hours, respectively, are not sufficient, nor is the latter period of three hours long enough to indicate the general behavior of the water with acid permanganate.

GENERAL REMARKS ON OTHER CHEMICAL DETERMINATIONS.

1. The determinations of total solids left on evaporation, of the loss on ignition of this solid residue, and even of chlorine, in the series of varied dilutions of identical or nearly identical liquids, show discrepancies which illustrate the comparative roughness of the methods by which these resnlts were obtained when very small quantities have to be dealt with.† The evaporation of 100 c. c. of water usually left a residue, the absolute weight of which was but a few milligrams, and a very little difference in the dryness attained, or in the atmospheric deposition on the surface of the platinum capsule, involved relatively large errors in the result. Even the volumetric processes for chlorine are far inferior in delicacy to those employed for the organic constituents.

2. As regards the results for nitrites and nitrates, the coincidence seems to be worth noting, which is often presented between alkaline reaction of a water and the occurrence of these salts in considerable or large quantity, suggesting as this does a recollection of the conditions under which nitrates are produced on the large scale in the decay of nitrogenous organic matter. The coincidence, however, is not always observable, nitrites and nitrates ocurring pretty largely in some cases without alkaline reaction, while in other instances (as Nos. 89, 90, and 91, containing the washings from starch manufacture) there was alkaline reaction, and also much nitrogenous matter, but no nitrites or nitrates. Mr. Noyes has drawn my attention to the fact that in the waters containing large amounts of nitrates, ammonia appears in but small proportion; hence ammonium nitrate seems to be rare, the bases constituent being rather for the most part non-volatile—no doubt calcium, magnesium, or one of the alkaline metals; this is worth notice in relation to possible reduction to nitrite and consequent loss of nitrogen in the combustion process. The view of Frankland that nitrites are producible in water by the reducing action of organic matter upon nitrates‡ is clearly sustained by the results for Nos. 64 and 65, these representing a water originally containing nitrates to which different amounts of an infusion of hay had been added; it seems by no means established that nitrites are *always* developed by reduction, some of Dr. Tanner's experiments which have been reported indicating that on the contrary these salts may be produced by oxidation, which if it go on leads to the formation of nitrates. Frankland's view, also, that nitrates are not found in waters deficient in dissolved oxygen, is in general accordance with the results obtained in this investigation, though there are a few instances—Nos. 20, 27, 43, and notably 33—in which nitrates are present to a considerable extent in waters with less than a full proportion of free oxygen in solution.

3. The experiments with tannin simply serve to show how utterly worthless is this "group-reagent" of Kämmerer for the purpose for which he has advocated its use.

4. The general series of analyses of the dissolved gases confirms what has been said on previous pages of the general report as to the number of varying conditions which influence the results in this direction—oxidizability of organic matter present, temperature, extent of exposure to the atmosphere, and interchange with it in both directions of gaseous constituents. In a number of cases the consumption of dissolved oxygen, and production in its place of carbon dioxide from the carbon of organic matter

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* In accordance with the remarks of Frankland: "Water Analysis; p. 55."

† It is true that Dr. Smart took no very special pains with these determinations, which were looked upon merely as incidental to the main object, checking to some extent the information as to the general character of each water. Still, this part of the work was done with fully average ordinary care.

‡ "Water Analysis," pp. 28 and 42.

is very obvious, but the extent to which this is found going on varies greatly, and is masked by the escape to a greater or less extent of the latter gas and reabsorption from the air of the former. The conclusion of Weyl and Zeitler,* from a few experiments, that the quantity of free oxygen in solution does not bear any fixed ratio to the quantity of acidified permanganate decolorized by a water, is sustained by many of the specimens in the main series, as for instance Nos. 60 to 80, inclusive. Nevertheless, it may be well to include an examination of the dissolved gases in the study of any water in regard to which the fullest chemical information is desired. In such a case the examination ought to be made with the least possible interval of time after collection of the sample, and preferably on the spot where the sample is taken, with observation of the temperature of water and air.

MICROSCOPICAL AND PATHOLOGICAL RESULTS.

Feeling my own incompetence properly to discuss these, I prefer to leave them to speak for themselves, except so far as Professor Martin has, as quoted in a previous part of the general report, given his views as to the methods employed and the general significance of the facts recorded—these views having been formed, however, while he still was ignorant of the history of the individual waters.

It may be said, I think, that the microscopic and culture observations indicate at the same time the real importance of connecting with a chemical examination of water a study in competent hands of its microscopic organisms, both as to number and kind, and also the difficulty often presented, either by the sparseness or more frequently the abundance of these organisms, in fairly estimating their average relation to the mass of the water. This difficulty is superadded, of course, to the imperfection of our knowledge as to the effects upon human health of some closely allied—even hardly distinguishable—organisms, of dangerous and harmless associations, and of perhaps the same organism in different stages of its life history. The probable general significance of certain large classes of organized forms seems, however, well established, and well worthy of attention.

It may also be said of the pathological experiments with rabbits, that, opening up as they do a new and almost untried field of research, they show the great complexity of conditions to be encountered, the necessity of careful attention to details, and of multiplying and varying such experiments as far as possible, and the caution which must be exercised in drawing generalized conclusions from them; but, on the other hand, the results so far obtained, many of which individually are exceedingly suggestive, seem to indicate that real value attaches to this method of investigation, not in the direction proposed by Emmerich (as a part of the ordinary examination of a drinking-water, in order to determine directly its wholesomeness or the reverse), but as the means in part of arriving at trustworthy grounds for the interpretation of chemical and microscopical results.

SANITARY CONCLUSIONS AND INTERPRETATION OF RESULTS.

To admit of easier comparison the results by the chief processes examined have been thrown into graphical form in Tables XIX and XX, of which the former refers to the natural waters and the latter to those artificially prepared.

(These tables will appear with the general report.)

Chemical results contrasted with actual sanitary history of the natural waters examined.

1. An inspection of Table XIX shows that *no strongly marked generic difference is presented by the results from any of the processes for the estimation of organic matter or its elements between the generally wholesome waters of Class I and the medically condemned and fairly assumed as pernicious waters of Class II.* Judging by the general impression of the curves upon the eye, one would be inclined to attribute somewhat more importance to the results involving nitrogen than to those dependent upon carbon, but neither will afford the means of broadly distinguishing the two classes. This conclusion is otherwise illustrated by the figures in Table XXI.

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* Zeitschr. f. phys. Chem. 5; 10 (1880).

TABLE XXI.—*Comparison of chemical results for waters of Classes I and II.*

	Least result.		Greatest result.		Average.	
	Class I.	Class II.	Class I.	Class II.	Class I.	Class II.
Organic carbon	.36	.33	7.20	7.79	2.36	2.08
Organic nitrogen	.08	.03	1.41	*6.88	.56	†.94
Sum of organic carbon and nitrogen	.44	.61	7.86	†8.31	2.92	†2.92
Nitrogen of free ammonia	.008	.008	.675	.295	.092	.090
Nitrogen of albuminoid ammonia	.016	.021	.268+	.214	.112	.099
Nitrogen of total ammonia	.028	.033	.704	.343	.204	.189
Oxygen consumed in one hour (Tidy)	.062	.082	4.008	3.340	.995	.791
Oxygen consumed in three hours (Tidy)	.210	.104	5.212	4.188	1.305	1.065
Oxygen consumed (Kubel)	None.	None.	7.443	6.000	2.140	1.271

* This figure is undoubtedly too high, in consequence of incomplete reduction of nitrates. The next highest is 2.36, and even this is probably higher than the truth, for the same reason.

† Including the no doubt erroneous highest single figure.

It will be seen from this table that no marked difference exists between the *highest*, *lowest*, or *average* result obtained by any of the processes for the waters of Class I and the corresponding result for those of Class II. No one could, with these figures to guide him, refer a water of unknown origin to one or the other of the two classes on the evidence afforded by chemical analysis, using any or all of the processes in question. The more varied results presented in Class III admit of being studied with some interest in connection with the history of the individual waters, but are not available for the main purpose of testing the chemical methods, as this class includes only waters the sanitary character of which in advance of examination was more or less doubtful—waters under suspicion only.

2. Making the most liberal allowance for the imperfection of the different processes for the estimation of organic matter or its constituents, it is well worthy of notice how very small is the absolute amount of organic matter indicated as present in many of the most dangerous waters, an amount so small as to furnish important evidence against any chemical theory of the production of disease from this source, any theory based on the simple assumption that some of the chemical products of the decomposition of organic matter are poisonous or noxious in their effect upon the human system. Thus, if *the whole* of the organic carbon and nitrogen found in such waters as Nos. 35 and 36, of the highly dangerous character of which there can scarcely be a doubt, existed as strychnine, it would be necessary to drink about half a gallon of the water at once in order to swallow an average *medicinal* dose of the alkaloid. It is not easy to believe that the ptomaines, or any other chemical products of putrefactive change as yet observed, can possess an intensity of toxic power so very much greater than that of the most energetic of recognized poisons. While numerous facts go to support the belief that, not to the effect of any chemical substances (such effect necessarily standing in definite relation to their quantity), but to the presence of living organisms with their power of practically unlimited self-multiplication, we must in all probability look for an explanation of, most at any rate, of the mischief attributable to drinking water, it is of course possible that indirectly a large amount of organic matter in water may be more dangerous than a smaller quantity, as furnishing on a greater scale the suitable material and conditions for the development of noxious as well as harmless organisms.*

Whether variations in the mere quantity of organic matter, within such limits as occur in water at all likely to be used for drinking, are of much importance in this respect, *i. e.*, as determinant of the presence or abundance of organisms, is a question which may be asked, and on it depends, I think, largely the utility of all attempts to determine or estimate the quantity of organic matter or its constituents as such.

3. A much more conspicuous difference between the waters of Classes I and II is presented by the results for nitrites and nitrates, as shown in Table XXII. (See last page.)

In this table a tenfold height is given to the ordinates representing the nitrites, the smaller quantity in which they occur requiring this exaggeration.

Here we find a very obvious connection between the results of chemical examination and the known sanitary character of the several waters, the salts of nitrous and nitric acid being either absent or present in but trifling amount in the waters of Class I, believed to be wholesome, almost universally present, and in many cases in large

* Tiemann and Preusse have suggested that a poluted water may more *probably* contain disease ferments than a pure one, but it should not be inferred that an impure water is necessarily pernicious. Quoted in Chem. News, January 16, 1880, 30, 31.

quantity, in the pernicious waters of Class II, and very variable as to presence and amount in the waters grouped together under the doubtful head of Class III. No aspect in which I have compared together the good and bad natural waters has afforded so definite a result as this.

This result is worthy of special attention in view of the different opinions which have been expressed as to the sanitary significance of nitrites and nitrates in water. Thus, Wanklyn says: * "The nitrates and nitrites have been erroneously regarded as measuring the defilement of water." "In fine, presence or abundance of nitrates does not show defilement by means of sewage, and deficiency of nitrates does not show absence of defilement. Many excellent waters have been condemned as unwholesome on account of the nitrates contained by them; and it cannot too strongly be insisted upon that the nitrates afford no data of any value in judging of the organic quality of a water." Augus Smith says: †

"There are many interesting questions to be asked regarding nitrates. I am inclined to think that their presence shows that the most dangerous state of the organic matter is past. When they appear in any solution, the chief escape of putrid gas seems to have ceased; the water may, however, be still dangerous to use, and, of course, is revolting to the imagination." * * * ‡ "Those nitrates, however, which do remain indicate that at least an equivalent of albuminous matter or sewage matter *did* exist."

Frankland clearly expresses his view § as to this evidence of "previous sewage contamination" thus:

"Large quantities [of nitrates] convict water of previous pollution by organic matters of animal origin. They tell only of the contamination which is past; but, by inference, they also declare the probable nature of the organic matter now present. * * * Whether or no the analyst should form an unfavorable opinion of the water from the amount of nitrates must depend upon the proportion of organic matter actually present, and on his confidence in the efficiency and uniform action of the purifying process."

As the basis of his determination of "previous sewage contamination" Frankland takes the sum of the nitrogen present as ammonical salts, nitrites, and nitrates, diminished by an allowance for the average amounts of these substances in rainwater; he therefore treats the significance of the ammonia as the same with that of the nitrites and nitrates, as evidence merely of the past presence of nitrogenous organic matter, of which a part *may* remain.

Griess has expressed a strong opinion‖ as to the sanitary importance of detecting nitrates, and the unfitness of water for drinking purposes when containing them.

Ekin ¶ attaches very great importance to the presence of nitrates and nitrites. Thus he says:

"Waters which have undoubtedly given rise to typhoid fever have been found by the writer over and over again not to contain more than 0.05 part of albuminoid ammonia in 1,000,000, and which, notwithstanding their containing a large excess of nitrates, have been passed by analysts of undoubted ability as being fit for drinking purposes. The attention of the writer was particularly drawn to this in the case of a district where typhoid fever was hardly ever absent, and where the conditions were such as pointed exclusively to water as being the aggravating cause. * * * Samples were taken when the pollution was evident, and analyzed. Two only were found to contain an excess of albuminoid ammonia, but all contained a large excess of nitrates. * * * The significance of an excess of nitrates has already been sufficiently dwelt upon, and we have seen that, both upon *a priori* grounds and as the result of actual experience, their presence in abnormal quantity is objectionable. * * * When the amount [of nitrates] exceeds 0.5 or 0.6 part [per 100,000], it points significantly to dangerous pollution; * * * nitrogen as nitrites should be invariably absent from a good water. * * * This view of the importance to be attached to an abnormal quantity of nitrates has been formed in spite of a considerable predisposition to a contrary opinion, and has been literally forced upon the writer again and again by the investigation of cases which really leave no doubt in the matter."

Reuben Haines, of Philadelphia, has furnished ** the details of some cases in his own experience, which, he says, are "in partial corroboration of the opinions of Mr. Ekin."

Among the artificially polluted waters of the investigation now reported on there are a number of samples of such general character as to attach to them the gravest suspicion on sanitary grounds, suspicion corroborated in sundry cases by the biological

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* J. A. Wanklyn, "Water Analysis," Lond. 1879; 97, 98.
† Chemical News September 3, 1869; 113.
‡ Chemical News, June 25, 1869; 305.
§ "Water Analysis for Sanitary Purposes"; 27.
‖ Ann. d. Chem. u. Pharm., CLIV; 336.
¶ "Potable Water," 2d ed., Lond., 1880; pp. 15, 16, 22, 25, 26, 27, 28, &c.
** "Methods for judging of the wholesomeness of drinking water." From Journal of the Franklin Institute, February, 1881.

tests applied to them; in which, nevertheless, nitrates and nitrites are not found; but in these waters we find the quantity of organic matter extraordinarily large, and generally accompanied by very large amounts of ammonia—*e. g.*, Nos. 119, 120, 121 containing water in which the dead body of an animal had been allowed to macerate; Nos. 122, 123, 124 containing much blood from a slaughter-house, and Nos. 137 and 138 containing the dejecta from typhoid fever patients.

Looking at the results from the natural waters of Classes I and II, and bearing in mind the conclusions reached by Müller, Schloesing and Müntz, Storer, Warington, and others * as to the process of nitrification being due to the presence of an organized ferment or ferments of bacterial character, the idea suggests itself whether the noxious character of waters containing largely of nitrates and nitrites—themselves presumed to be harmless—and but very little organic matter—which ought to be present, of some sort, to support the "previous contamination" view—*may not be in reality due to the presence of a special nitrifying ferment, itself to be classed among the lower organisms capable of propagating disease.*

4. Two points require to be borne in mind, suggestive of caution in drawing such conclusions as the above in regard to the sanitary in connection with the chemical character of water.

In the first place, the samples examined may possibly have undergone chemical change in the interval from their collection to their reaching the analysts, so that, for example, organic matter may have disappeared or nitrates may have been formed. With the precautions taken to lose as little time as possible, there does not seem much likelihood of such changes having occurred to so serious an extent as to essentially alter the character of the water.

In the second place, with the object which I had in view, of obtaining samples of water capable of producing disease, it was necessary to take what may be called *exaggerated instances* of mischief—well marked or comparatively violent cases of illness—since no others could well be traced with sufficient strength of probability to their supposed cause, and it may very possibly be that the organic impurities present in the waters concerned in such cases are not the same as those which would produce slighter, but in time serious, ill effects. Slighter forms of disease, in reality attributable to drinking-water, may perhaps be numerous, and possibly of various types, but generally the difficulty will be too great of securing, in view of the many factors concerned, any satisfactory evidence as to their cause. The collection of strongly-marked cases only, neglecting slighter ones if such exist, involves to some extent the same fault in principle as the commonly applied test of the death-rate for particular diseases in the discussion of local sanitary conditions; there may be numerous cases of illness, with but few deaths. The same difficulty also is experienced in trying pathological experiments on the lower animals; only strongly marked effects can be noted or satisfactorily connected with their supposed cause.

5. In regard to the comparatively rough determinations of chlorine, the results are, in many of the cases of water from shallow wells, significant enough of contamination by fluid animal excreta. The amounts of chlorine found in specimens Nos. 2, 3, and 4 of water from the deep artesian well at Charleston, S. C., and in No. 22 from a well near the sea on Staten Island, and Nos. 50 and 51 from a well, and No. 52 from a pond in the neighborhood of the sea at Newport, R. I., illustrate the need for thought as to the natural source of a water in drawing conclusions in connection with the presence of chlorides. Even in cases in which chlorine has come in with organic matter, the impropriety of too hastily deciding, as is sometimes done, that a small quantity indicates vegetable and a large amount animal contamination, is illustrated by the results for No. 65, containing an infusion of hay or dry herbage,† and for Nos. 87 and 88, containing the alkaline washings from wood pulp at a paper-mill, in contrast with those for Nos. 120 and 121, containing a very foul infusion of the body of a dead animal, and for Nos. 138 and 139, containing morbid animal matter from cases of typhoid and scarlet fever.

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* Comptes rendus: 84, 301; 85, 22, 1018. Jour. Chem. Soc. (Lond.), January, 1878, 44; July, 1879, 429 Chem. News, November 4, 1881, 217, &c.

† It is possible that salt may have been sprinkled over this hay in curing it, as is sometimes done, though I have no special reason to suppose so. It was upland, not salt-marsh, hay.

Biological results contrasted with the actual character of the waters examined.

The lists of waters marked (independently) by Professor Martin and Dr. Hartwell as "dangerous" and "suspicious" on the basis of the biological observations are summarized, in connection with the classes represented, in Table XXIII.

TABLE XXIII.—*Biological classification of waters.*

Class.	No. in class.	Professor Martin.		Dr. Hartwell.	
		Dangerous.	Suspicious.	Dangerous.	Suspicious.
I	19	.....	4	.....	7
II	19	.....	2	.....	1
III	20	2	1	1	3
IV	20	3	3	3	2
V	21	4	5	2	10
VI	21	4	1	1	6
VII	15	4	3	4	7
VIII	4	1	2	2	1

1. It is evident on inspection of this table for Classes I to III, that, as has been remarked on a previous page, the biological methods employed will not afford the means of deciding between a wholesome and an unwholesome natural water. Several of the waters believed to be fairly wholesome for human consumption, certainly in use for drinking purposes on a large scale, are marked "suspicious," while not one of the waters believed to have proved themselves pernicious when used by man are set down as "dangerous."

2. In many cases the waters which produced most decided effects upon the rabbits contained *very large* amounts of organic matter, so large as to probably invalidate a comparison with the natural waters or with much more dilute specimens of artificial preparation.

3. On the other hand, we find in several instances, on comparing the pathological results from three different strengths of a solution of the same organic material, that it is not the strongest which has produced the most marked effects.

4. In probable support of the idea that it is not mainly the quantity of organic matter, but the presence and nature of low organisms which render drinking water unwholesome, such cases deserve attention as No. 83 in contrast with Nos. 84 and 85, and also Nos. 131, 132, and 133 (if the deaths of comparison rabbits be not considered to vitiate the results) in contrast with Nos. 134, 135, and 136. Here the pernicious character of waters containing relatively but very little organic matter seems to be distinctly indicated.

5. It is pretty plain that much difficulty in the interpretation of the biological results arises from too great differences of absolute strength in the solutions of organic matter used. In any future attempt to extend investigation in this direction it would be well to more nearly equalize the dilution, though it might perhaps prove necessary to use in all cases more organic matter than is usually found in potable water of natural origin.

Chemical results as to animal in contrast with vegetable organic matter in water.

1. In general the conclusions are sustained which have been usually drawn in regard to the source of organic matter, based on the more highly nitrogenous character of that from animal than that from vegetable *débris*. This remark applies to the ratio of organic C : N obtained by the combustion process (although the value of the figures is much reduced by the errors in the method which have been pointed out), and also to the amounts of albuminoid ammonia obtained, and the consumption of oxygen from acid permanganate.

2. But the necessity for caution in drawing such conclusions, or the propriety of substituting for the statement that a given water is polluted by, say, animal matter, rather the simple assertion that the polluting material is of highly nitrogenous character, is illustrated by such cases as Nos. 89, 90, and 91, containing the alkaline washings from the manufacture of starch, and Nos. 98, 99, and 100, containing the refuse from canning tomatoes. These waters might well be supposed to be contaminated with animal matter from the evidence afforded by the chemical results, interpreted in the usual way.

3. On the other hand, the results for Nos. 104, 105, and 106, containing a watery infusion of human fæces, especially the C : N ratio, might be taken to indicate the

presence of vegetable matter. This fact, well deserving attention from a sanitary point of view, is opposed to the evidence of pollution obtained where urine alone is concerned, and might modify the conclusions drawn in cases involving drainage from mixed solid and fluid excreta. The fact itself is intelligible in view of the tendency to accumulation and ultimate rejection from the intestines of the vegetable fiber* of our food and the products of its limited alteration, as well as the highly carbonaceous character of the biliary discharges.

4. The different rate of removal from water of organic carbon and organic nitrogen is in one form illustrated by the comparison of No. 119 with No. 120 and No. 121, all three containing the watery liquid in which the body of a dead animal had been macerated, as also No. 128 in contrast with Nos. 129 and 130, all containing washings from wool. The true effect of the changes taking place in the water is, however, blended with and partially obscured by the effect of difference of strength on the errors which have been pointed out belonging to determinations by the combustion process. The bearing of such changes in the C: N ratio, from both causes, on the conclusions to be drawn as to the source of pollution is very obvious.

5. Dr. Smart, in interpreting his results by the albuminoid-ammonia process, aided, however, in some cases, by his application of the Kubel form of the permanganate process, has for most of the waters in which the organic matter was of known character (though unknown at the time to *him*) attempted to distinguish between that of vegetable and that of animal origin, and his conclusions are given in column 45 of Table X. On examining these it will be seen that in a very large proportion of cases he has been right, while some of those in which his deductions are incorrect are intelligible in the light of full consideration of all the facts. Thus, he has referred Nos. 105 and 106, containing infusion of human fæces, to the class of vegetable matter, this case having been alluded to above; and Nos. 108 and 109, containing drainings from a pile of stable manure, to the same class, this being in many respects an analogous case, and, indeed, a more strongly marked one of its kind.

Biological results as to animal in contrast with vegetable organic matter in water.

1. Decidedly the most noteworthy result under this head is the well-marked pathological effect produced upon rabbits by the injection of waters contaminated solely by such vegetable matter as would usually be esteemed harmless. An account has been given on previous pages of the general report of the repeated experiments with water containing an infusion of dead forest leaves (No. 68), all leading to essentially the same result. A like effect followed from the experiments with the peaty waters of the Dismal Swamp (Nos. 78 and 79).

While there have hitherto been occasional allusions by sanitary writers† to slight indisposition now and then experienced by persons drinking the peat water of mountain streams, it has been usually assumed that peaty water is *not* unwholesome, strong language on this head being often used,‡ and that, in general, organic matter of vegetable origin is harmless, or comparatively harmless, while that of animal origin is highly dangerous.§ The results above referred to indicate that under the special conditions of the experiments with rabbits vegetable matter representing mainly or largely alteration products of woody fiber may be in a high degree pernicious.

2. It will be seen that for nearly all the waters classed as "dangerous" by Professor Martin and Dr. Hartwell the ratio of organic C: N was rather high.

3. The above conclusion as to the apparent possibility of vegetable organic matter proving itself decidedly injurious has to be qualified by observing that in the well-marked cases of such results the amount of organic matter present in the water was large, and it would not be safe to affirm on this evidence alone that similars waters, if diluted to the ordinary potable standard,‖ would still prove themselves capable of causing disease or death in the animals experimented on; indeed, the evidence tends rather the other way, so far as the experiments go which were made by injecting the rabbits with *the same quantities* of weaker solutions. But, on the other hand, water containing as much vegetable organic matter as No. 78 is often used for drinking purposes in peaty districts, and this very Dismal Swamp water has often been taken by choice as the supply for ships leaving port, and has been spoken of as a source of supply for the city of Norfolk; so that the discussion of wholesomeness or unwholesomeness of such water is not without practical interest.

4. If the theory be accepted, which has so much in its favor, attributing the pro-

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* The infusion used was strained, but not filtered. It contained a good deal of very fine suspended material.

† Angus Smith, in Chem. News, June 25, 1869; 304. Ekin, "Potable Water," p. 15; foot-note. 6th Report of Pollution of Rivers Commission, p. 34.

‡ Tidy, Jour. Chem. Soc. (Lond.), Jan., 1879; 65. Ekin, "Potable Water," p. 15.

§ Frankland, "Water Analysis," 93-97. Tidy, Jour. Chem Soc. (Lond.), Jan., 1879, 80-83. Ekin, "Potable Water," pp. 12, 13, 14, 15, &c. R. Haines, Methods for judging of wholesomeness of drinking waters, p. 11. De Chaumont, Arch. Ch. Pharm., XVII, 124.

‖ See 6th Report of Pollution of Rivers Commission, p. 34.

duction of disease by organic matter in drinking water not to any specifically poisonous *substance* or substances, but to the presence and action of living organisms, it seems quite conceivable that a water containing organic matter of any kind, including vegetable matter, may be harmless at one time, and harmful at another, when perhaps a different stage of fermentation or putrefactive change may have been entered upon, and special organisms may have made their appearance or entered upon a new phase of existence. Thus there might possibly be safety in drinking a peaty water, or water filtered through beds of dead forest leaves, when fresh, danger when after a certain amount of atmospheric exposure bacterial organisms had become developed, and safety again, perhaps, after the growth of such organisms had fallen off and more or less of the available organic matter had been consumed. I have been informed that old ship-captains who have often carried the water of the Dismal Swamp to sea entertain a belief that this water undergoes a "kind of fermentation," after which it becomes remarkably good and wholesome. In support of some such idea as to different stages passed through by a water (containing vegetable matter) as to the development of organisms and sanitary character, leading to the possibility, on its being stored, of wholesomeness at one time and unwholesomeness at another, the microscopical and biological reports of Nos. 62, and 69, 70, and 71, are worthy of notice.

Evidence afforded by chemical results as to putrescent or non-putrescent character of organic matter in water.

1. Tidy has claimed* as on of the merits of the permanganate process, that it enables the distinction to be drawn between "putrescent and easily oxidizable" and "non-putrescent or less easily oxidizable" organic matter, and has given the results of some experiments to show that the former are, for the most part at any rate, disposed of within the first hour; hence his rule as to determining separately the consumption of oxygen in that time and in three hours, and comparing the results, by means of which comparison he says "we obtain data of great value by which to judge the nature of the organic impurity." In column 28 of Table X, I have given the ratio of the consumption of oxygen from permanganate used as directed by Tidy in one hour to that in three hours, the latter quantity assumed = 100. The results for those waters, the nature of the organic matter in which was known, are obviously affected variously by sundry conditions, such as the different strengths of solutions, the presence together of both easily and less easily oxidizable matter, &c., but on the whole do not afford much support to the opinion expressed by Tidy. He distinctly assumes animal matter to be, at any rate as a rule, more "putrescent and easily oxidizable" than vegetable matter, but on examining the percentages in column 28, taking the averages for the different classes of waters, we find—

	Per cent.
Organic matter of vegetable origin:	
For Class IV	84.0
For Class V	80.8
Organic matter of animal origin:	
For Class VI	74.5
For Class VII	77.6
For Class VIII	79.0

Thus, although the differences are not very great, the proportionate consumption of oxygen within the first hour is rather greater for those waters containing vegetable than for those containing animal matter. Again, judging merely by appearance, smell, &c., I should say that the waters in the foulest and most actively putrescent condition were those containing the alkaline washings from a starch factory (Nos. 89, 90, 91), the washings from the bag-filters of a sugar refinery (Nos. 92, 93, 94), the refuse from canning tomatoes (Nos. 98, 99, 100), infusion of human fæcal matter (Nos. 104, 105, 106), infusion of a body of a dead animal (Nos. 119, 120, 121), mixed drainings from a slaughter-house (Nos. 125, 126, 127), and the dejecta from typhoid fever patients (Nos. 137, 138); the average consumption of oxygen for all of these in one hour is 80 per cent. of that in three hours; almost exactly the same with the mean of all the above figures for the five classes examined (giving them equal value), viz, 79.2 per cent.

2. On the other hand, Dr. Smart has expressed the opinion, based upon his previous extensive experience with the albuminoid-ammonia process, aside from his work with it in connection with the present investigation, that *gradual* evolution of albuminoid ammonia indicates the presence of organic matter, whether of vegetable or animal origin, in a fresh, or comparatively fresh, condition, while *rapid* evolution indicates that the organic matter is in a putrescent or decomposing condition. In column 45 of Table X will be found his application of this principle of interpretation to his results obtained from the waters examined; the detailed facts as to the rate of evolu-

*Jour. Chem. Soc. (Lond.) Jan., 1879; 78, 80, 97.

tion of albuminoid ammonia in the measures of distillate successively collected will be found in Appendix D. It will be seen that in a very large proportion of the cases before him Dr. Smart has interpreted correctly the general character of the water as to putrescence or comparative freshness of condition of the organic matter. Examples, however, of erroneous results from this principle of interpretation are furnished by Nos. 77, 92, 93, 94, 125, 128, and 131, nearly all of which, it may be observed, were very dilute liquids, and perhaps by the waters (Nos. 113, 114, 116, 117, and 118) containing mixed sewage from Richmond and Washington, though these, also quite dilute, can hardly be quoted as examples involving a known degree of putrescence on the part of the organic matter.

Biological results in connection with putrescent or non-putrescent character of organic matter in water.

On the whole the biological results obtained, taken in connection with the history and condition of the water samples in which the nature of the organic matter was known, are in accordance with the general belief that putrescent organic matter is more dangerous than that in a fresh or but slowly decomposing condition. Taking the twenty waters which have been noticed above, as containing the most obviously foul, evil smelling, and actively putrescent material, in some of vegetable, in others of animal origin, and comparing these with the lists of waters, as classified by Professor Martin and Dr. Hartwell, we find nine classes as "dangerous," and seven as "suspicious"; of the remaining four, the fact that two represented the weakest dilutions of materials, which in stronger solutions produced marked pathological effects, deserves to be noticed.

GENERAL CONCLUSIONS, WITH A VIEW TO SANITARY APPLICATION, AS TO THE VALUE, SEPARATELY AND COLLECTIVELY, OF THE DIFFERENT PROCESSES OF WATER ANALYSIS WHICH HAVE BEEN UNDER EXAMINATION.

1. It is not possible to decide absolutely upon the wholesomeness or unwholesomeness of a drinking water by the mere use of any of the processes examined for the estimation of *organic matter*, or its constituents.

2. I would even go further, and say that, in judging the sanitary character of a water, not only must such processes be used in connection with the investigation of other evidence of a more general sort, as to the source and history of the water, but should even be deemed of secondary importance in weighing the reasons for accepting or rejecting a water not manifestly unfit for drinking on other grounds.*

3. There are no sound grounds on which to establish such general "standards of purity" as have been proposed, looking to exact amounts of organic carbon or nitrogen, "albuminoid ammonia," oxygen of permanganate consumed, &c., as permissible or not. Distinctions drawn by the application of such standards are arbitrary and may be misleading.

4. Two entirely legitimate directions seem to be open for the useful examination by chemical means of the organic constituents of drinking water, namely, first, the detection of *very gross* pollution, such as the contamination of the water of a well by accidental bursting or crushing of soil-pipes, extensive leakage of drains,† &c., and secondly, the periodical examination of a water supply, as of a great city, in order that, the normal or usual character of the water having been previously ascertained, any suspicious changes which from time to time may occur shall be promptly detected and their cause investigated.

5. In connection with this latter application of water analysis there seems to be no objection to the establishment of *local* "standards of purity" for drinking water, based on sufficiently thorough examination of the water supply in its usual condition.

6. With the facts of this investigation before me, I am inclined to attach special and very great importance to a careful determination of the nitrites and nitrates in water to be used for drinking.

7. If I had intrusted to me the charge of watching a large city water supply I should

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* It will not do merely to throw all doubts on the side of the rejection of a water, as has been more or less advocated by writers on water analysis, for there are often interests of too serious character involved in such rejection to admit of its being decided on, save upon really convincing evidence of its necessity. In view of the great and increasing difficulty of securing an adequate supply of water of satisfactory character for very large cities, is it an unpractical fancy that there may yet come to be provided a double supply through separate pipes: 1st, of water for drinking and cooking purposes only; and 2d, of water less carefully selected as to source and storage for bathing, washing, house and street cleaning, extinguishing fires, &c., the former at any rate dispensed through meters to regulate consumption?

† Dr. J. S. Billings, U. S. A., of the National Board of Health, has suggested to me in conversation a useful subject of inquiry, viz, the possibility of tracing up the passage of polluting material through a soil by leaching samples of the soil itself, taken at various distances from the source of pollution, or from the water likely to be affected, and chemically examining the liquids obtained.

use all three of the principal processes for the examination of the organic matter present; each gives a certain amount of information which the others do not afford.

Under circumstances admitting only of the use of simpler means of investigation, the albuminoid ammonia and permanganate processes might be employed together, but in no case should one only of these methods be resorted to, such a course entailing practically the neglect of carbon on the one hand or nitrogen on the other.

PRACTICAL SUGGESTIONS, DRAWN FROM THE EXPERIENCE OF THE INVESTIGATION NOW REPORTED ON, AS TO THE USE IN THEIR PRESENT FORM OF THE CHEMICAL PROCESSES STUDIED.

Examination of water samples in general.

1. Great care should be taken that water samples be placed in the hands of the analyst and their examination begun with the least possible delay after they have been collected. The changes which take place, sometimes rapidly, on keeping, may seriously affect the results, especialy in the case of waters much polluted by foul organic matter.

2. It is very desirable that, besides examining a water in its perfectly fresh condition, samples of it should be set aside, in half-filled but closed glass-stoppered bottles, for some time—say 10 or 12 days—and one of these examined every day or two, so as to trace the character and extent of the changes undergone. Not only may conclusions be drawn from such a series of observations as to the general stability or decomposibility of the organic matter present, but light will be thrown upon the changes which may be expected to occur under ordinary conditions when the water is stored for use, as in cisterns, wells during periods of drought, or carelessly allowed to remain stagnant in pitchers, water-coolers, &c.

Combustion process.

1. In applying this process, no matter how skillful or well trained the analyst may be, duplicate or even triplicate concordant results should be insisted upon before accepting the determinations as trustworthy.

2. In order to avoid the presence in the atmosphere about the water-bath used for the evaporation of ammonia derived from coal-gas, the bath should be heated by steam brought in a small, closed pipe from a distant boiler, preferably situated in another room, and the waste steam and condensed water therefrom should be in like manner carried off to a safe distance.

Albuminoid-ammonia process.

1. In order to avoid the uncertain ending of the collection of ammonia, whether "free" or "albuminoid," it would be well to adopt the rule that the distillation be stopped when, and not before, the last measure of distillate collected contains less than a *certain proportion*—say 1 per cent.—of the whole quantity of ammonia already collected. This would in many cases involve the necessity of replenishing the liquid contents of the retort with ammonia-free water.

2. In order to diminish the loss of amines or other volatile forms of nitrogenous matter, a separate distillation should be made with alkaline permanganate added *at once*, in addition to the usual course of treatment prescribed by Wanklyn—distillation begun with sodium carbonate, and continued after addition of the alkaline permanganate. The results of the two separate distillations should then be compared.

3. In reporting the results obtained by the albuminoid-ammonia process, including the determination of free ammonia, the details of the evolution of ammonia, as collected by separate measures of distillate, should always be given.

Permanganate process.

1. In view of the evidence obtained rendering probable the loss of organic matter by volatilization in the use of acidified permanganate at a boiling temperature, the Tidy form of the process is rather to be recommended than that of Kubel if but one be used.

2. On the other hand, the advantage of more extended oxidizing action, and the greater *general* accordance of the results by the Kubel process with those for organic carbon by the combustion process, make it desirable that as far as possible the same advantages should be secured by substituting the influence of time for that of temperature, and that the time during which the permanganate is allowed to act in the Tidy process should be increased to at least 12, better to 24, hours, *several* determinations (on different samples set aside at the same time) being made at such intermediate intervals as 1, 3, 6, 9, and 12 hours, in order to trace the progress of the oxidation.

SUGGESTIONS AS TO POSSIBLE IMPROVEMENTS ON THE PROCESSES EXAMINED DESERVING FURTHER INVESTIGATION.

Combustion process.

1. I would propose to evaporate the water, not under ordinary pressure and in contact with the atmosphere, as usual, but as the specimens of water were evaporated for the biological experiments, in a closed vessel immersed in a water-bath and connected with a good (water jet) air pump, so as to secure a nearly complete removal of air, with a condensing worm to dispose in part of the aqueous vapor given off. It would not do to simply place the water in a flask, since the residue could not be removed for combustion, but it would not be difficult to arrange a suitable vacuum vessel, with wide mouth and tightly clamped on cover, within which might be placed the usual glass dish to receive the water, and the feed might be managed through a nearly capillary tube with a glass stop-cock. By such an arrangement the evaporation might be effected within a moderate time at a fixed temperature much lower than the boiling point, thus probably reducing any loss from simple volatilization of organic matter; the nearly complete exclusion of air would tend to greatly diminish or do away with loss of organic matter by oxidation, and permit of large reduction in the quantity of sulphurous acid used; for the same reason the tendency to formation of sulphuric acid would be reduced to a minimum, and the absorption of ammonia from the atmosphere about the dish would be altogether prevented. In testing this last-named effect, two bulb-tubes containing pure sulphuric acid might be interposed between the vacuum chamber and the pump; the contents of the one to be tested for ammonia given off from the water, those of the other to guard against any trace of ammonia coming back from the outside air during irregular action of the stream of water.

2. In order to avoid loss during the evaporation of readily volatile substances, such as butyric, valerianic, &c., acids, to dispense with the necessity for the uncertain and unsatisfactory correction for ammonia lost by dissociation, to get rid of the influence on the determination of organic nitrogen of any errors in the determination of the total ammonia, and to avoid corresponding difficulties arising from the presence of nitrates if these be allowed to remain, it might be well to evaporate at first with the addition of a small excess of magnesia (as recommended by Lechartier), thus removing all ammonia, and then, the water having been brought down to a small volume, add a moderate excess only of sulphurous acid* with a drop of a solution of a ferrous salt (as directed by Frankland), and complete the evaporation to dryness—the whole process to be carried out in a jet-pump vacuum, as above suggested.

3. Further experiments are desirable in order to completely determine the merits and defects of the Williams ("copper-zinc couple") method for the removal of nitrates.

4. Some preliminary experiments of my own have seemed to show that nitrates and nitrites may be completely reduced by evaporating to a small bulk with no great excess of phosphorous or hypophosphorous acid, guarding against the evolution of phosphureted hydrogen by the low temperature employed, then adding magnesia in small excess and completing the evaporation, thus leaving the residue in a pulverulent instead of sticky condition, easy of removal from the dish, and probably allowing of complete combustion without inconvenience from the final oxidation of the small excess of phosphite or hypophosphite, and without any wrapping up of carbon particles. This plan deserves to be carefully tested.

Albuminoid-ammonia process, including determination of free ammonia.

1. In order to prevent or at least to largely reduce and render uniform, the loss of ammonia from imperfect condensation, I would prefer to effect the distillation, not by a lamp-flame, but in a retort of uniformly determined shape and size, uniformly immersed in a bath of saline solution or other suitable material kept at a uniform temperature—say 102° or 105° C.—by means of steam, and to condense in a glass worm surrounded by ice-water, sufficiently long to bring the distillate to a uniform temperature, not exceeding, say, 5° C.

2. It would be perhaps still better to conduct the distillation in a completely closed apparatus, with a fixed difference of temperature between the retort and the far end of the fully effective condensing tube, with a glass stop-cock to draw off the distillate in successive measured portions, and a little safety-valve (mercury or other) near the cold end to prevent any dangerous difference of external and internal pressure.

3. In the determination of *free* ammonia, with a view to distinguishing as sharply as possible between ammonia really existing as such, or in ammoniacal salts, and that found by breaking up of organic matter, it might be well to try a closed distilling

* I doubt, however, the possibility of fully reducing nitrates by means of sulphurous acid, if they are present in large quantity.

apparatus, connected with a (water-jet) air-pump, so as to maintain a partial vacuum within, keeping the retort a ta fixed temperature much below 100° C., and collecting the whole of the ammonia in a flask and one or more bulb-tubes, containing rather weak mineral acid, interposed between the condenser and the pump. This would, however, be attended with the disadvantage of not readily permitting the progress of the evolution of ammonia to be traced by its collection in separate successive measures of distillate; and it would become necessary to ascertain whether the application of the Nessler test would be in any way interfered with by the sodium salts formed from the acid used to collect the ammonia.

4. In order to overcome, if possible, the most serious difficulty in the way of a correct determination of free ammonia, namely, the ready breaking up of urea (and other amides), when present, on heating with sodium carbonate, it would be well to ascertain at how low a temperature and within what time, if at all, ammonia really existing in ammoniacal salts could be completely driven off from an *extremely dilute* solution by adding a small excess of magnesia and maintaining a (water-jet) air pump vacuum above the liquid, forming a stratum of small depth, with bulb-tubes of acid between the liquid and the pump to intercept the ammonia, and guard-tubes to prevent any being received from the air; in other words to ascertain whether Schlœsing's method for the determination of ammonia admits of being applied to such excessively minute amounts of it as the water analyst is concerned with.

5. In the conduct of the albuminoid-ammonia process proper, *i. e.*, the distillation with alkaline permanganate, I would propose that the original volume of liquid in the retort he maintained *constant*, by running in at the proper rate, through a nearly capillary tube with a glass stop-cock, ammonia-free distilled water. And, in cases in which the amount of organic matter is so large as to wholly, or in great part, reduce the usual charge of alkaline permanganate, I would determine by a preliminary experiment at about what rate the reagent is used up, and would then progressively supply its solution, instead of simply pure water, at such a rate as to keep the original strength as nearly as possible unaltered.

Permanganate process.

1. The principle involved in the last paragraph applies also to this process. Instead of using a fixed amount of permanganate at first, and adding a second or third charge only when the former has been completely reduced, there ought to be a fixed excess at the end of the action, or rather there should be present a constant excess all through the process. Hence, when a preliminary experiment has shown that more than the usual charge of permanganate will be needed, and about the rate at which it will be consumed, for the final experiment additional permanganate solution should be gradually dripped in, from a nearly capillary tube, at such a rate as to maintain the original excess as nearly as possible constant.

2. It is desirable that the process be carried on at a pretty nearly fixed temperature.* If the Tidy method be followed, a temperature of say 20° C., could, with a little management, generally be secured, and the flasks kept approximately at this point during the time required for the action.

SUGGESTIONS AS TO FURTHER INVESTIGATIONS IN GENERAL CONNECTION WITH THE SUBJECT-MATTER OF THIS REPORT.

1. It is much to be wished that more extended biological experiments should be made upon the effects of water variously polluted on the lower animals, and that in such experiments the action of water introduced into the stomach as well as hypodermically injected should be tested, and other animals (such as dogs) used as well as rabbits.

2. It would be well to have chemical examinations, on a strictly uniform plan, from time to time made of the water supply in a few of the largest cities at periods when, not mortuary statistics, but the general assent of well-informed members of the medical profession, ascertained through local sanitary authorities, indicates unusual prevalence of, or unusual exemption from, the classes of disease most probably capable of origination from the organic pollution of drinking water.

3. I would *especially* suggest a combined chemical and biological inquiry as to the possible effects upon living animals of the ferment or ferments of nitrification in different stages of that process. In connection with this some minor questions connected with the development of nitrites and nitrates from decomposing organic matter are pointed to, by facts observed in the course of the investigation now reported on, as deserving further examination.

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*For experiments on the varying extent of action of permanganate upon organic matter in water at different temperatures, see Bericht. d. deutsch. chem. Gesellsch., 14; 1015.

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REPORT ON THE RESULTS OF AN INVESTIGATION MADE BY DIRECTION OF THE NATIONAL BOARD OF HEALTH, AS TO THE CHEMICAL METHODS IN USE FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

By Prof. J. W. MALLET, F. R. S., University of Virginia.

ORIGIN OF THE INVESTIGATION.

This research was undertaken in compliance with the instructions of a letter from the president of the National Board of Health, written on behalf of the executive committee of the Board, and dated Washington, December 29, 1880.

The idea of such an investigation was suggested by the difference of opinion and practice among chemists as to the methods for chemically examining the organic constituents of potable waters, differences which have been brought prominently to the notice of sanitarians by repeated public discussions of the subject within the last ten or twelve years. In spite of these discussions much uncertainty and difference of opinion still exist as to the relative and absolute degrees of accuracy of several, at least, among the various processes in use, especially those most relied upon, and as to the interpretation of the results they yield, and the practical conclusions to be drawn from them for sanitary purposes. Clearly this state of things is unsatisfactory, in view of the commonly recognized importance of organically impure water as a factor in the production of some forms of disease, the natural expectation that to a properly devised system of chemical examination we may reasonably look in part for the means of forming at least a probable opinion with regard to the character and wholesomeness of a drinking water, and the fact that chemical examinations in great numbers are actually made of various waters, and reports are based thereupon for sanitary purposes, while the value of the methods used and conclusions drawn is still in dispute.

If the scientific literature of the subject be passed in review, it will be seen that attempts to compare the methods in question have hitherto been much marred by two serious defects. In the first place, such attempts have been made chiefly by the originators or improvers of particular processes, and their immediate assistants, or by strong advocates, not to say partisans, of such several processes, rather than by absolutely impartial persons*, and from time to time much of the warmth of personal controversy has entered into these discussions. In the second place, direct experimental comparisons have to but a very limited extent been made of the results of the different processes as applied at the same time to precisely similar samples of the same water. Some such experiments have been recorded, but surprisingly few in view of the amount of verbal argument as to the very point these experiments ought to settle. Even in cases in which water from the same source has been examined by different methods, the samples have usually been drawn at different times or examined after keeping for different lengths of time, thus rendering possible the assumption that organic matter was not originally present to the same extent, or had been altered or lost to an unknown extent before it reached the hands of the respective analysts. Twelve months ago any one desiring to compare for himself the results of the different processes in use as applied to absolutely similar samples of water, would have found but scanty material for his purpose. Within the last year some data for such comparison have been furnished by examinations made by more than one method, of the London water supply, by Messrs. Crookes, Odling, and Meymott Tidy†, but these experiments all refer to water of nearly the same general character, and illustrating no marked variations of composition.

Another difficulty presents itself if we attempt to discuss the comparative merits of the various methods for determining the organic constituents of water, namely, that some authorities, as Dr. Frankland, aim at the quantitative determination of the whole

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* Such papers as that of Tiemann & Preusse (Berichte d. deutsch chem. Gesellscheft, 12, 1906–1924) may properly be called impartial, but represent rather comparative criticism, based upon general principles, than direct experimental comparison.

† Chemical News, February 4, 1881, p. 51; March 4, 1881, p. 104; April 14, 1881, p. 174; May 6, 1881, p. 204; June 10, 1881, p. 266. From the statement as to collection of the samples for these examinations it may be inferred that they were examined under quite similar conditions by two methods (the "combustion" and "oxygen," *i. e.*, permanganate processes).

of the organic carbon and nitrogen present, although confessedly these, or an unknown proportion of them, may occur in harmless states of combination; while others, as Professor Tidy and Mr. Wanklyn, attempt to determine such portions of one or both of these elements as most readily undergo chemical change (oxidation of carbon, formation of ammonia from nitrogen), it being by many supposed that, in general, forms of organic matter readily alterable under the conditions of experiment are most likely to be those concerned in putrefactive decay, and likely to involve danger to health, although both these suppositions are without satisfactory proof, and it is difficult to draw the line between more and less easily alterable organic matter. It is plain, and is generally admitted, that, in the present state of our knowledge of the causes of disease, chemistry can give no direct answer to the question whether the organic matter in a particular water is harmful or not; but even a partial and indirect answer would be valuable, if attainable, could a decision be had as to the presence or absence of such forms of organic matter as are most *likely* to be dangerous, or which, from their character and sources, we should certainly desire to see excluded from our supplies of potable water. Although this particular phase of the general question has been much discussed, actual experiments bearing upon it in a satisfactory way are almost wholly wanting.

Of the immense number of water analyses, illustrating rival methods, which have been published, nearly all fall, as to organic constituents, under one or other of two heads:

1st. The use of a given process to determine such constituents in ordinary drinking water of at least fair character, and in actual use, the chief point furnishing evidence as to the value of the method being simply the degree of uniformity or self-consistency of the results; and

2d. The use of a process to determine, as a direct test of its trustworthiness, the carbon or nitrogen, or to estimate some portion of one or both in known quantities of pure organic substances in dilute solution, such as cane sugar, starch, gum, morphine, gelatine, urea, and the like. It is to be noted that a large proportion of the not very large number of substances which have been thus examined are not of themselves injurious to health, and others do not occur in natural waters.

Examples of the former class of analyses may be found in the Journal of the Chemical Society (London) for June, 1876, p. 850, and January, 1879, p. 46, and in the sixth report of the (English) Pollution of Rivers Commission, 1874. It is worthy of remark how very few strictly duplicate analyses are recorded of water identically the same in character, by which the degree of uniformity presented by the results may be sharply tested. Examples of the latter class occur in the Journal of the Chemical Society for December, 1867, p. 593; March, 1868, pp. 83 and 94; and May, 1868, p. 163.

In view of what has been said, it seemed that information on this subject of greater value than any hitherto published might probably be obtained by a research based upon the following general principles:

GUIDING PRINCIPLES PROPOSED.

1. The work should be in charge of some one uncommitted to any preformed opinion as to the relative or absolute merits of the various processes of water analysis. The present writer may fairly claim this qualification, having neither expressed nor formed any opinion on the subject.

2. The person in general charge of the work should collect from natural sources a number of samples of water for examination, and prepare others by artificial additions of organic matter to pure or at any rate wholesome water.

3. These samples should illustrate various typical classes of water, as for instance such natural water as is used on a large scale with no medical evidence against its wholesomeness, such on the contrary as there may be good reason to believe has actually produced disease, water of good character artificially polluted with definite amounts of offensive and probably dangerous organic materials (urine, sewage, objectionable manufacturing refuse, &c.), and good water to which have been added less objectionable forms of organic matter, and those more likely to occur under purely natural conditions (drainings from herbage, dead forest leaves, &c.)

4. The samples should be submitted to chemical examination by the different processes to be compared, rejecting those processes which are generally admitted to be untrustworthy, and selecting for study those only which have established a fair *prima facie* claim to consideration, and are actually in use.

5. The actual examination of the samples by each different process should be carried out by a distinct and independent analyst, working apart from, and without concert with, the analysts engaged upon the other methods.

6. All the chemists taking part in the work should have had sound general training in laboratory work, and each should be prepared by a special course of training for the particular process to be intrusted to him. There should, of course, be ample provision of all needful apparatus and material of the best quality.

7. Each chemist should make a special study of any doubtful or obscure points connected with the working of the process in his charge, either such as are already known to involve difficulty or uncertainty, or such as might be noticed during the progress of the work.

8. In no case should the analysts know anything of the history or source of the water examined, each sample being known to them only by an arbitrary mark, and reported on by the same.

9. Such arrangements should be made for the preservation, distribution, and transportation of the samples that they should reach the analysts in absolutely identical condition.

10. The examination of each sample by the different methods should take place simultaneously, so that keeping for different lengths of time should not have given rise to difference of condition.

11. The absolute accuracy of the results obtainable by each process should be tested, and the range of error to be looked for ascertained, by duplicate or triplicate analyses made under strictly identical conditions, and by examination of carefully prepared solutions containing known amounts of chemically pure substances.

12. The effect upon the results of each process should be ascertained of the greater or less *dilution*—within pretty wide limits—of the organic matter in solution, this being a point which seems not to have hitherto received sufficient attention.

13. A sufficient number of experiments should be made to furnish a fair basis for induction, but the quantity of work done should be made altogether subordinate to its accuracy.

14. Any incidental points of sanitary interest which might present themselves in the course of the work should as far as possible be examined.

15. It would be very desirable to connect with the chemical analysis of the various samples of water a careful microscopical examination for organized matter, and pathological experiments upon the lower animals.

16. Before proceeding to a general discussion of the results obtained, it would be well that each analyst—still in ignorance of the history or source of the waters he had examined—should independently interpret his own results, as far as possible, following the rules which have been laid down by the originators of and workers with the several processes as to the meaning of their results. It is commonly and truly said that a final opinion on the character of a water should not be based upon the mere results of any chemical process, but that all the known facts in relation to the water ought to be taken into account. Nevertheless, a chemical examination, if it be of any value at all, ought to add something to our knowledge of a water as derived from other sources; the judgment formed on the evidence of the chemical examination alone may be a conditional one, or subject to modification by a knowledge of other facts in regard to the water, but without such knowledge *some* judgment should be possible, or chemical analysis might as well be dispensed with altogether, and to avoid bias, conscious or unconscious, it would be well that this judgment should be formed and recorded before the general history of the water is known.

17. In the general discussion of results, those obtained by the different processes as applied to the same sample of water should be compared together, both directly in numerical form and as interpreted in relation to the thence deduced character of the water.

18. The results by each process and their interpretation should also be compared with the actual history of the several water samples.

19. On the basis of this comparison such questions should be examined as, how far organic impurities of vegetable can be distinguished from those of animal origin, and whether the standards laid down for judging of the safety or danger of using a particular drinking water are properly justified.

20. All experimental results obtained should be impartially published, so as to fairly represent the facts, and leave them open to interpretation or discussion by any one.

ARRANGEMENTS ACTUALLY MADE FOR THE WORK—PROCUREMENT OF SAMPLES OF WATER FOR EXAMINATION.

In January last a correspondence was begun with persons in various parts of the country with a view to obtaining suitable specimens of natural waters for examination, and such forms of manufacturing refuse and other organic matter as it was desirable should be used in preparing artificially polluted specimens. This correspondence was actively kept up for about nine months.

As it was considered a matter of special interest that as many samples as possible should be secured of waters whose use there was really good medical reason for believing had actually produced illness, the following notice of the investigation and request for information as to cases of disease attributed to drinking water was in-

serted in the National Board of Health Bulletin for January 15, 1881, and in following numbers of the same up to October:

CHEMICAL EXAMINATION OF DRINKING WATER.

[Request for specimens of suspected water.]

A careful study of the chief methods in use for the chemical examination of potable water, so far as organic matter is concerned, has been undertaken by order of the National Board of Health. It is particularly requested of the correspondents of the Board, of medical men throughout the country, and of others interested in sanitary matters, that any well-marked case of disease which may seem on medical grounds fairly attributable to organic impurities in drinking water be promptly reported to Dr. J. W. Mallet, University of Virginia Post-Office, Albemarle County, Virginia, with a few lines stating clearly the medical nature of the case and the character of the evidence on which the water in question is suspected of having actually caused disease in persons who have used it.

It is further desired that a sample of each such water be forwarded for examination, *but not until notice has been received from Dr. Mallet that the analysts are ready to proceed with it*, since it is important that no useless delay should occur between the shipping of the sample and its investigation in the laboratory. In notifying any one who may be able to furnish specimens of suspected waters that may be forwarded, clear instructions will be sent as to the quantity of water required, and the mode of collecting, packing, and shipping it.

It is particularly desired that no case be presented on doubtful or vague evidence, since one important object of the inquiry demands that all such be rejected, and only those cases examined which involve the strongest grounds for believing that mischief has really been caused by organically foul drinking water.

The cost of packages and transportation for samples will be borne by the Board of Health.

The Bulletin reaching a very large number of physicians and others interested in sanitary matters throughout the United States, this notice resulted in a large harvest of letters communicating various sets of facts supposed to establish cases of mischief arising from the use of particular drinking waters. Usually the letters first received required further correspondence, and answers to sundry questions in detail, before the evidence as to the harmfulness of the water in question could be fairly weighed. It was desired that this evidence should be of a purely medical and circumstantial character, looking to the fact of the illness observed and its nature, the use by the patient or patients of the water suspected, the coincidence of illness of a given kind on the part of several persons, all using the same water, and exemption from like symptoms on the part of others, living under generally similar conditions, but not using the water in question, the illness being of a kind which might reasonably be ascribed to the use of organically impure water, the absence of other and more probable causes, &c. As had been feared beforehand, under rigid sifting, the evidence in much the larger number of cases proved insufficient to satisfactorily sustain the indictment against the water complained of, but a fair number, perhaps quite as many as might have been expected, of good cases were secured.

It being, of course, impossible to draw an absolutely sharp line between the cases of sufficient and insufficient evidence, some of those received for chemical examination were put down as doubtful, including certain waters which were considered more or less suspicious by the municipal authorities or the physicians of particular places, and for the analysis of some of which urgent requests were preferred, on the ground of the public interest. As such requests of course looked, in part at least, to deciding on the character of the suspected water by the results of the analysis, which for the purposes of the present inquiry would involve the vicious arguing in a circle, or mixing up of evidence, using the suspicious character of a water to gauge the amount or kind of impurity to be regarded as dangerous, and then using the amount or kind of impurity found to decide on the validity of the suspicion—a form of faulty logic not seldom to be met with in writings on water analysis—reports furnished were confined to a simple statement of the actual results obtained, without interpretation of the same.

To represent wholesome waters, or those to which no serious imputation of unwholesomeness attaches, resort was had chiefly to the regular water supply of some of the principal cities, samples being taken at times when no unusual disturbance of condition, disagreeable taste or odor, or other obvious objection, was observable. Thought and care have generally been bestowed upon the choice of the sources of these supplies; they are subject to the observation, as to the sanitary influence, of large masses of population and numerous physicians, and probably no distinct charge of the actual production of disease could be brought against them and sustained. In

certain cases water was selected for examination in this class of wholesome waters on the ground of its source precluding the possibility of contamination, at any rate by organic impurities from the usual sources of such.

In each case in which water was brought from a distance, there was sent beforehand to the person from whom it was to be received a printed slip of directions for the mode of collection of the sample, the vessels (always of glass, new, perfectly clean, and rinsed out twice with the water to be examined), the proper securing of the samples against contamination on the way, the marking for identification, and the method of shipment so as to secure the least possible delay in transportation. Four gallons of water was the quantity called for of each sample.

The artificially polluted waters were prepared with care, the different degrees of dilution obtained by exact measurement in correctly graduated vessels, each specimen rendered perfectly uniform by thorough mixture before its division into the portions for the different analysts, and such solid matter in suspension removed as might have prevented uniformity of condition on analysis.

It need scarcely be said that throughout the investigation, both in the preservation of the specimens of water, their division into portions for analysis, and their treatment in the hands of the analysts, the most scrupulous care was taken to avoid dust or other accidental sources of organic matter.

CLASSES OF WATERS EXAMINED.

1. Distilled water, and watery solutions containing known amounts of pure substances of definite composition in preliminary work, looking to the special training of the analysts in the different processes.
2. Natural waters believed to be of good and wholesome character.
3. Natural waters which there is good ground for believing have actually caused disease on the part of persons drinking them.
4. Natural waters of doubtful, but more or less suspicious, character.
5. Artifically prepared waters, made by adding to good, wholesome water, which was itself analyzed, determinate amounts of various *vegetable* infusions, selecting such forms of organic matter as are liable to be taken up under ordinary natural conditions of water supply; as, for instance, the drainings from unbruised fresh herbage, from decaying forest leaves, &c.
6. Artificially prepared waters, made as above, with various forms of *vegetable* refuse from manufacturing operations, such as the washings from sugar-refining filters, from starch factories, &c.
7. Artificially prepared waters, as above, to which had been added different forms of organic matter of *animal* (or mixed animal and vegetable) origin, being such as are liable to contaminate the water supply of a place under common conditions arising from the daily life of men and lower animals in the neighborhood.
8. Artificially prepared waters, as above, containing different kinds of *animal* refuse from manufacturing or industrial operations.
9. Artificially prepared waters, as above, to which had been added morbid products from certain selected diseases of the human subject—viz, typhoid fever, scarlet fever, and yellow fever. It was intended to include also cholera, but no opportunity occurred of procuring the desired material from the true Asiatic type of the disease.

In examining the effect of various degrees of dilution of all these artificially prepared solutions, except the last, three strengths of each were employed, containing one-fifth per cent., 1 per cent., and 5 per cent., respectively, of the added polluting liquid. The strength of this liquid itself, in its original state, necessarily varied very considerably in different cases.*

10. Solutions in distilled water of determined amounts of pure substances of definite chemical composition. This series was employed as the means of specially testing the degree of absolute accuracy of each method. It was submitted to the analysts at the very close of their work, after many months' experience, and with special exhortations to spare no pains in getting as good results as possible. The chemical substances added to the water (selected from among the definite products of animal life or of the putrefactive decay of animal material) were themselves prepared with the greatest care, very accurately weighed† under conditions to exclude any errors from hygrometric moisture, and dissolved in exactly measured volumes of water. The distilled water, to the extent of twice the quantity to be used for each solution, was thoroughly mixed by pouring from one vessel to another, one-half used in preparing the solution, which was rendered perfectly uniform by the same process of pouring back and forth repeatedly, and the other half sent to the analysts to be examined si-

* As but one water a day could be examined, an interval of two days occurred between the examination of the first and last of these three strengths. To obviate, as far as possible, the influence on the final conclusions of any change occurring within this time, the three solutions of different strengths were taken as often in one order as another of the six possible permutations in this respect.

† Sufficiently large quantities of the solutions were prepared to admit of the solid materials therefor being weighed with an error not exceeding a very small fraction of the whole amount.

multaneously with the solution. Thus no error could arise from the difference of character of successive portions of distilled water from the same still.

In this series the three strengths decided upon for solutions of each substance represented amounts of the solid substance dissolved in the proportion 1:5:9*. *The absolute amounts taken were such as to represent pretty fairly quantities needing to be dealt with in ordinary water analysis.*

It was proposed to add to the above list of waters for examination a series of samples obtained at the same time from various points along the course of one of the great American rivers, as it was hoped that thus some contribution might be made to the facts available for the discussion of the interesting question of the self-purification of flowing water, about which there has not long since been much discussion in Europe, where all the rivers examined are of comparatively short course. But, on careful consideration of the matter, and after talking it over with an officer of the United Engineer Corps of high authority on the hydrographic and meteorological conditions of the Mississippi and its tributaries, the difficulties seemed to be so great in the way of securing reasonably definite and simple conditions of collection and experiment that this idea was abandoned.

SUMMARY OF PROCESSES IN USE OR PROPOSED, AND SELECTION OF THOSE TO BE EXAMINED.

The following methods for the determination or estimation of organic matter in drinking water were dismissed from consideration for the reasons assigned in connection with each, and because none of them have come into general use.

The attempt of J. Loew† to actually isolate the organic matter existing in a specimen of water, stands alone,‡ and differs from all the ordinary methods which are indirect in principle. He heated the water at moderate temperature until carbon dioxide was expelled and calcium and magnesium carbonates and ferric hydrate were thrown down, filtered off the precipitate after subsidence, and washed it with distilled water. The washed precipitate was heated with water nearly to the boiling point, and ammonium chloride cautiously added in small portions as long as any smell of escaping ammonia could be perceived. A large part of the precipitate dissolved, and the insoluble residue of silica, iron, &c., was filtered off. The solution was freed from any excess of ammonia by allowing it to stand over sulphuric acid, and a solution of cupric acetate then added as long as a precipitate formed. This precipitate was washed, suspended in warm water which had been deprived of air by boiling, and decomposed by a stream of washed sulphureted hydrogen gas. The excess of sulphureted hydrogen having been removed from the filtered liquid by a stream of carbon dioxide, this liquid was warmed on a water bath, filtered again, and finally evaporated in a glass capsule on the water bath, leaving usually a very minute amount of organic matter, supposed to have been in combination with iron and to be analogous in character to the so-called crenic and apocrenic acids. The original water from which the earthy carbonates had been thrown down by heating, decanted and filtered, was concentrated by evaporation at a moderate temperature, and after cooling precipitated with a sufficient amount of a solution of neutral lead acetate. The liquid was allowed to clear itself by subsidence, decanted, and the lead precipitate filtered off. This precipitate was washed free of lead chloride with warm water, treated with solution of sodium theosulphate to remove lead sulphate, the residue washed, suspended in water, decomposed by sulphureted hydrogen, the liquid filtered, and the clear filtrate cautiously evaporated to dryness, leaving usually minute traces of organic matter. The original water, after this treatment with neutral lead acetate, was now submitted to a like precipitation with basic lead acetate, the well-washed precipitate obtained was decomposed by sulphureted hydrogen, and the filtered liquid gently evaporated to dryness, leaving the largest portion of the organic matter originally present in the form of a yellow varnish-like, or gum-like film, with acid reaction and sourish taste, on the surface of the capsule. This material was charred by heating, burned away with little or no ash, but submitted to Lassayne's test gave no evidence of the presence of nitrogen. No further organic matter could be obtained from the original water after the removal of the copper and both lead precipitates. The whole process is quite too cumbrous and uncertain in result, requires very large quantities of water (100 pounds or more), is complicated by the use of too many reagents, and involves too much probability of extensive alteration of the organic matter sought for.

F. Bellamy§ proposed to prepare a solution of 8 grams of alum in 100 c. c. of water,

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* Each solution was prepared with separately weighed solid material, so that there was no difference in the time each solution was kept until examined by the analysts.

† Zeitschrift für anal. Chemis., 5ter Jahrg.; 23.

‡ E. Péligot has made somewhat similar experiments on the drinking water of Paris by precipitation with metallic salts.—Ann. Chim. et Phys. [4], 3; 213.

§ Archiv. der Pharm, [II], 136; 112 (from Journ. de Pharm. et de Chim.).

gradually add to it 12 c. c. of a 10 per cent. solution of potassium hydrate, so that the first-formed precipitate redissolves, and add 5 c. c. of this solution to a liter of the water to be examined, shaking well, and bringing the precipitate after standing for 12 or 14 hours into a tube of about 15 millimeters in diameter. The quantity of mixed organic and inorganic constituents in this precipitate was to be estimated from the height to which it reached in the tube, while the proportion of organic matter was to be judged of from the color. On treating the precipitate with hydrochloric or acetic acid, the aluminum hydrate dissolved, while humus-like organic matter was for the most part left behind. This was only proposed as the means of approximately estimating the amount of organic matter, and obviously the approximation could be but a very rough one.

A. Smetham * acidified a liter of the water with phosphoric acid, evaporated to about 50 c. c., added 1 grain of potassium dichromate, 1 grain of potassium permanganate, and 20 c. c. of sulphuric acid of specific gravity 1.4, and distilled in a small retort until but 20 c. c. remained. The carbon dioxide given off was collected in baryta water, with proper precautions for the expulsion of the gas originally in the water, and against the action of the air, the barium carbonate was filtered off, dissolved in hydrochloric acid, and the barium precipitated and weighed as sulphate. This process only aims at determining the carbon of the organic matter, taking no account of nitrogen. The precautions necessary to avoid serious error are as troublesome as those required in the Frankland combustion process, for which this oxidation in the liquid way presents itself as a partial substitute. There is unsatisfactory doubt as to the completeness of the oxidation of the carbon, the author himself finding that urea yielded only 80 per cent. of its carbon unless distilled a second time with further addition of sulphuric acid and permanganate. The abstractor for the Chem. Soc. Jour. suggests that in the presence of nitrates oxidation of the organic matter would take place to some extent during the evaporation with phosphoric acid, and this would render the carbon estimation too low.

H. Fleck's process† involves the addition to the water under examination of a solution of silver nitrate in sodium theosulphate, made alkaline by caustic soda, metallic silver being reduced from this solution by organic matter of easily oxidizable character. The solution in question is prepared of standard strength, added in excess to the water, the quantity used being noted, and the whole boiled for ten minutes, or until the finely divided precipitate first obtained collects into heavy, dark-colored flocks, separating easily from the liquid. Standard solution of potassium iodide is now added until a drop of the liquid taken out upon a white porcelain plate and treated with a drop of solution of potassium dichromate, hydrochloric acid and starch turns blue at the surface of contact of the two. The quantity of potassium iodide used gives the amount of unreduced silver in the liquid, and this by subtraction from the whole amount of silver originally used indicates the quantity of silver reduced by the organic matter present.

The general aim of this method is essentially the same as that of the permanganate process, to be hereafter discussed. It shares all the difficulties of the latter, and is open to the same objections, with the further disadvantage attending all volumetric processes (so-called "spotting" processes) which require the withdrawal of small samples of the main solution to be separately tested for the close of the reaction employed. Fleck's standard solutions are very liable to change, and probably a serious disturbing influence is also to be feared from the varying intensity of the light under which the reduction of the silver solution by the organic matter occurs. It was claimed by Fleck that the special advantages of his method consisted in the action on the silver solution mainly of easily oxidizable, and therefore, as he assumed, easily fermentable and putrescible, forms of organic matter,‡ which, by a further assumption commonly made, were taken to be also the forms of such matter most dangerous to health; and, further, that this process was particularly adapted to the detection and estimation of *volatile* forms of organic matter in water. Fleck's own experiments do not fully support these claims, and they seem to have been proved invalid by the investigation of Tiemann and Preusse,§ who, on a direct comparison of this method with Kubel's permanganate process, found the latter quicker and better in both respects.

All of the other methods which have been proposed may be considered as modifications of four processes, which have been often referred to as—

The ignition process;
The combustion process;
The permanganate process;
The albuminoid ammonia process.

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* Jour. Chem. Soc., April, 1881, 196 (from Analyst, 1880, 5; 156).

† Jour. f. prkt. Chem. [2]; 4; 364. The method has been re-examined by Tiemann & Preusse. Ber. d. deutsch. chem. Gesellsch, 12; 1906.

‡ The recent assertion by Loew and Bokowry (Pflüger's Arch. 25; 150), that the distinction may be drawn between *living* and *dead* protoplasm by the superior reducing effect of the former on a very dilute alkaline solution of silver nitrate, requires much further investigation to give it adequate support.

§ Ber d. deutsch. Chem. Gesellsch.—*Loc. cit.*

An examination by transmitted light of the color of the water as seen in a layer of considerable depth has been recommended by several experimenters, but this can at best be considered (as regards the estimation of organic matter) a mere adjunct to the chemical examination. Such an examination is of course desirable for general sanitary purposes as affording some measure of the clearness of the water, its degree of freedom from suspended solid particles, and, incidentally, it may be well enough to observe the character and depth of color presented; but this alone cannot properly be received as a trustworthy, independent method for the estimation of organic matter.

IGNITION PROCESS.

This has been in use since an earlier date than belongs to any of the other processes, although the errors and imperfections connected with it have been repeatedly pointed out. Up to about thirty years ago—so far as any account was taken of organic matter in water—analysts were accustomed to evaporate the water to dryness at a temperature assumed to be capable of removing all moisture without charring or burning organic substances, determining the weight of the residue, igniting this in the air, weighing again, and counting the difference of the two weighings as representing the organic matter burned off. In 1856 Hofmann and Blyth* pointed out some of the defacts of this procedure, and suggested that the loss on ignition of the solid residue of a water could be made more nearly than before to represent the organic matters, by adding a known weight of sodium carbonate to the water before evaporation, thus excluding from the loss ammonia, moisture, and hydrochloric acid resulting from decomposition of magnesium chloride. In 1865, W. A. Miller,† in a general discussion of the analysis of potable waters, recognized the imperfection of the process, and recommended that a known quantity—say about .3 gram—of sodium carbonate should be added to a liter of water, this to be evaporated to apparent dryness on a steam-bath, the drying completed in an air-bath at a temperature of 140° or not over 150° C., maintained for one hour, the residue weighed, the organic matter burned off at a red heat barely visible in daylight, and the residue when cold again weighed. The various precautions necessary to secure accurate weighings were noted, and it was prescribed that after ignition the residue should be treated with a saturated solution of carbonic acid in distilled water, as first recommended by D. T. Clark, of which two or three ounces should be evaporated in the vessel used, and the residue again dried for an hour in the air-bath at the same temperature as that used for the first desiccation. The errors due to the decomposition of ammoniacal salts during the evaporation, and of nitrates during ignition, were noticed, and the result was stated to be "an approximative estimate of the amount of orgnic matter." Frankland and Armstrong,‡ in examining this method, dried the residue, both before and after gentle ignition in contact with air, at 120°–130° C., treating the final residue with carbonic acid water as often as increase of weight was produced. They showed that urea, if present in a water so examined, is partially dissipated during evaporation with sodium carbonate, while on the other hand the remainder cannot be completely burnt away, carbon and nitrogen probably remaining in the residue as sodium cyanate or cyanurate. They noticed also that in the treatment of the residues of some waters with carbonic acid solution, there was indefinitely continued increase of weight. The conclusion announced was that "on the one hand there may be much more organic matter in a water than is represented by the total loss on ignition;" "on the other hand, this determination may indicate the presence of a considerable amount of organic matter in a water which is wholly free from it;" "all that can be inferred from the loss on ignition is that, when it is large, the water is probably contaminated with animal or vegetable organic matter, or has been previously in contact with decaying animal matters."

Agnus Smith§ preferred to dry the residue before ignition at 100° C., admitting that some water would be retained, but stating that organic matter begins to be given off from some residues even at that temperature. He did not deny the inaccuracy of the quantitative results obtained, but was of opinion that "the results, however, of this method are very useful." He pointed out that in waters containing nitrates and nitrites no organic matter would be apparent on burning unless more should be present than these salts could oxidize. He laid much stress, however, upon the general conclusions to be drawn from the appearances presented by the residue on ignition, saying: "Still, it is remarkable what a clear insight is given into the quality of water by simply boiling down a few thousand grains and burning the residue. We can, by the eye and the smell, detect humous or peaty acids, nitrogenous organic substances and

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* Report to the President of the General Board of Health on the Metropolis Water Supply, by Hofmann and Blyth quoted in Jour. Chem. Soc. (Lond.); March, 1868; p. 77.

† Jour. Chem. Soc. (Lond.); May, 1865; p. 119.

‡ Jour. Chem. Soc. (Lond.); March, 1868; p. 79.

§ Memoirs of Lit. and Phil. Soc. of Manchester, 3d series, vol. 4; Chem. News, June 25, 1869; 306, and September 3, 1869; 113.

nitrates, and estimate their amount to a very useful point of accuracy. There may be times when this is the only experiment that can be made. After doing this, and trying other methods many hundred times, I still return to it as delicate, and little liable to fail. The want of numerical results is a serious objection, rendering the plan unfit for use when public reports are to be made of the analyses; but it is an excellent guide for the chemist in his laboratory: we may even decide by it the animal or vegetable origin of the matter." Kubel and Tiemann* recommend drying the original residue at 150°–180° C., and recognize ignition afterwards, moistening with solution of ammonium carbonate, and drying again at 180°, as affording a merely approximate determination of organic matter, and one which becomes very inaccurate if nitrates, sulphates, or chlorides be present in large quantity.

Wanklyn,† in connection with the determination of total solid residue from a water, suggests that this residue may be gently ignited, and the observation recorded, whether it blackens during the ignition, and that the weight after ignition may likewise be taken, but says that the loss on ignition is valueless as an indication of the quantity of organic matter present. Tidy,‡ in his valuable paper on the determination of organic matter in potable water, points out the demerits of the ignition process by remarking that "this process presupposes three things:

"(*a*) That no organic matter is lost and none gained during the evaporation of the water.

"(*β*) That all the organic matter is burnt off by the ignition of a residue.

"(*γ*) That nothing but organic matter is lost by ignition.

"But in all three points the process fails."

He considers, however, that there are "cases where the indications afforded by the ignition process may prove of value," namely, in the analysis of sewage, in the absence or nearly complete absence of nitrates, a coarse approximate indication is obtained, from the loss on ignition, as to the extent of impurity; the occurence of blackening on ignition indicates the presence of organic matter, but the degree of blackening cannot be trusted as indicating the larger or smaller amount of such matter present; and "the smell evolved by the ignition of a water residue often reveals important facts," distinctive odors being obtained from particular kinds of animal and vegetable organic matter, from that of sea-water residues, &c.

Tiemann and Preusse,§ in their comparison of different methods, assume that the residue of evaporation is dried at 180° C., ignited with access of air, treated with ammonium carbonate, and dried again at same temperature as before. These authors remark on some of the sources of error, and conclude that the result stands in no direct proportion to the fixed organic matter originally present in the water.

A. Wagner,‖ while admitting that no really accurate method is known for quantitatively determining the organic matter in water, has proposed the following means for obtaining an approximate result: The water having been evaporated, the residue is to be separated by treatment with distilled water into an insoluble and a soluble portion, the latter containing the greater part of the organic matter. The insoluble portion is to be dried, weighed, ignited, treated with ammonium carbonate, dried and weighed again, the loss of weight being taken as organic matter. The soluble portion, if nitrates be absent or present in traces only, is to be evaporated, the residue dried, weighed, ignited, and again weighed. But if nitrates be present in larger quantity, so that the organic matter will not suffice to change nitrates into carbonates, a little of a solution of pure sugar is to be added before ignition. The loss of weight represents the weight of the organic matter plus the difference due to the conversion of the quantity of nitrates present into the corresponding carbonates, and this difference is to be calculated from a special determination of nitrates, and subtracted.

Fresenius, in his standard treatise of Quantative Analysis,¶ mentions drying of the water residue at 180° C., gentle ignition, and treatment with ammonium carbonate, but says that the results are only approximate, since we never know the exact condition of magnesium carbonate, either in the dried or the ignited residue, and further errors are introduced by the expulsion of variable amounts of carbon dioxide from the carbonates by the action of silicic acid or oxide.

In fine, this ignition process is manifestly incorrect, rendered so by many disturbing influences: irregular loss of water by various substances liable to be present, as by calcium sulphate; decomposition of nitrates by heat in the absence of organic matter; action of these nitrates on organic matter when present, converting them into carbonates; exchange to some extent of chlorine for oxygen on the part of magnesium chloride; decomposing effect of silicic acid upon the salts of other acids; conversion of metallic salts of organic acids into carbonates; partial conversion of

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* Anleitung zur Untersuzhung von Wasser. 2te Aufl.; 1874; 17, 18.
† Wanklyn and Chapman: Water Analysis; 5th ed., 1879; 21.
‡ Jour. Chem. Soc. (Lond.); Jan., 1879; 47.
§ Berichte d. deutsch. Chem. Gesellsch.; 12; 1906.
‖ Zeitschrift für anal. chem., 20 ter Jahrg.; 323.
¶ 5 te Aufl.

magnesium carbonate into hydrate; possible volatilization of alkaline chlorides; incomplete combustion of particles of carbon; and other sources of error. The only reason for repeating in the course of the present investigation any experiments of this kind was found in the claim that some clue to the amount and nature of the organic matter is afforded by the appearance and smell of the residue during ignition; and, as the analysts were to work in ignorance of the actual source of each specimen of water, an opportunity was afforded to test, with very little trouble, the validity of this claim. It was determined, therefore, to apply the ignition process, including even weighings before and after ignition, to the residues obtained in determining the total solids, merely as an incidental feature of the general plan, and by no means as a test of this as a method for determining organic matter, for which purpose it stands already completely condemned.

COMBUSTION PROCESS.

In 1864 Weltzien* determined the nitrates in water by ignition of the residue from evaporation with finely divided metallic copper, and employed for the estimation of organic carbon a process consisting in acidulating the water with sulphuric acid, evaporating to dryness, and igniting the residue with cupric oxide, as in an ultimate organic analysis. Frankland and Armstrong point out that this mode of determining the carbon of organic matter was vitiated by the sulphuric acid expelling volatile organic acids, if present, and by its liberating nitrous and nitric acids, and thus causing oxidation and loss of organic matter during the evaporation.

In 1866 Heintz† also suggested the application of a combustion of the water residue with lead chromate, or in a stream of oxygen, to the determination of the organic carbon, carbon dioxide being driven off finally from the carbonates of the residue by means of hydrochloric acid and collected along with that produced by combustion, while a separate determination of the gas derived from the carbonates alone (without combustion) would enable the correction for this latter to be made. The correction would in many cases vastly exceed the quantity of organic carbon to be determined, and the process in the form proposed by Heintz involves the possibility of errors, from various sources, quite too serious in proportion to the minute quantities of carbon usually present in a water residue.

The combustion process as the means of determining the carbon, and in addition the nitrogen, of the organic matter of water first acquired real importance in the hands of Frankland and Armstrong,‡ whose names have been generally associated with it. They introduced the use of sulphurous acid, added to the water before evaporation, for the expulsion of carbon dioxide from the carbonates present, and for the removal of the nitrogen of nitrites and nitrates, leaving only that of organic matter and ammonia; and they for the first time made the combustion of the water residue in a tube thoroughly exhausted of air by the Sprengel mercurial pump, so that both the carbon and the nitrogen of the organic matter present might be determined, the former as carbon dioxide, the latter as elementary nitrogen, by volume, with the ordinary precautions of gaseous volumetric analysis. The method worked out by these chemists has been described in minute detail, not only in their original paper, but in a small book§ specially devoted to this subject, and has been applied by the authors to the examination‖ of a very large number of natural waters.

This process has been used to a moderate extent by others, but not generally or largely. It has been criticized in various quarters. The chief objections made to it may be represented by the following:

Wanklyn, Chapman and Smith¶ suggested that the absolute error in the amounts of carbon and nitrogen, as determined in ten test experiments reported by Frankland and Armstrong in their original paper, formed too large a proportion of, or might even equal the total amounts of these elements present in the residue from an ordinary natural water; the probability of loss of organic matter during the evaporation; the probability of a portion of the nitrates escaping decomposition by the sulphurous acid added, and consequent vitiation of the organic nitrogen determination; and the probability of free sulphuric acid being found by oxidation of the sulphurous acid used, and consequent destructive action of such sulphuric acid on the organic matter. A few experiments were reported, going to show that on evaporation with excess of sulphurous acid, even in the presence of iron and phosphates, the destruction of

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* Ann. Chem. u. Pharm., 132, 215; quoted by Frankland and Armstrong. Jour. Chem. Soc. (Lond.) March, 1868; 77.

† Zeitschr. für anal. Chem., 5ter Jahrg.; 18.

‡ Jour. Chem. Soc. (Lond.), March, 1868; 77.

§ Frankland: Water analysis for sanitary purposes, with hints for the interpretation of results. London, 1880.

‖ Sixth Report of the Royal Commission on the Pollution of Rivers on the Domestic Water Supply of Great Britain. London, 1874.

¶ Jour., Chem. Soc. (Lond.) April, 1868; 152.

nitrates was incomplete. These objections have been repeated,* with the modification that "the nitric acid may be utterly destroyed in that manner" (*i. e.*, evaporation with sulphurous acid), "but it is only too plain that that cannot be done without destruction of the organic matter."

Kubel and Tiemann† lay especial stress upon the probability of volatile substances being produced during the decay of the easily alterable, and therefore assumed specially important, forms of organic matter, and of such substances being lost during the evaporation. They also remark that the process requires complicated apparatus, reagents not easily to be obtained of the necessary degree of purity, and a large expenditure of time; and they raise the question, without undertaking to decide it one way or the other, whether the results are worth the trouble requisite to obtain them.

Tidy‡ makes light of objections founded upon the manipulative skill required and the length of time consumed, on the ground that accuracy and delicacy are the main things to be aimed at in water analysis, and ease and rapidity should not be weighed in the same balance with them. He, however, objects, *ab initio*, to any process necessitating the evaporation of the water to dryness, and points out that both gain and loss of organic matter during evaporation are to be feared, and throws grave doubt upon what he calls the "cautiously guarded phrase" of Mills that "substantially satisfactory evidence has been given that there is no material loss during evaporation," requiring more definite proof that no organic matter is oxidized, destroyed by the heat, or volatilized during this stage of the process.

Tidy further expresses doubt as to the completeness of the destruction of nitrates by sulphurous acid under the conditions recommended by Frankland, and states, as the result of experiments made by himself, that when the nitrogen, as nitrates, exceeds 1 part per 100,000 (or 10 parts per 1,000,000), the reduction in question cannot be depended upon. Admitting that Frankland had directed the evaporation of a large additional amount of sulphurous acid upon the residue when nitrates in such quantity are present, Tidy considers that great danger is thereby entailed of destructive action by the sulphurous acid itself or by sulphuric acid produced from it by oxidation. He puts the difficulty thus: "Add too little sulphurous acid, and the reduction of your nitrate is incomplete; add too much, and there is a possibility, at any rate, that your organic matter may cease to be." He mentions as "a difficulty of some importance, although by no means insuperable," the obtaining pure cupric oxide for the combustion, failure in this respect resulting in the introduction of "inconveniently large errors." He considers, from his own more recent experiments, that the objection raised by Wanklyn, as to the magnitude of the experimental error, in comparison with the whole quantity to be determined, has not the force which Wanklyn would give to it. He concludes, however, that, whilst the determination of the organic carbon by this process is to be relied upon, the same value does not attach to the determination of the organic nitrogen, in regard to which the difficulty of reducing the nitrates and of effecting the complete expulsion of the nitrogen, the presence of ammonia, and the possibility of occluded nitrogen in the copper, constitute a series of important possible errors, and hence he doubts how far the ratio of the organic carbon and nitrogen can be trusted as evidence of the source of the organic matter—that is, whether it be vegetable or animal.

Tiemann and Preusse§ object to the process on the ground that it ignores organic matter volatilized by boiling in acid solution, and decomposition undergone by organic matter by evaporation in the presence of sulphurous acid and ferrous chloride; and, in general, that the amounts of carbon and nitrogen differing in organic compounds, no evidence is afforded of the absolute quantity of organic matter present, and properly comparable results can only be obtained in case it should chance that the waters compared contained similar mixtures of organic compounds.

Sundry modifications of this process in its details have been proposed, some of which have been recognized as more or less feasible alternatives by Frankland.

Thus, Schuber‖ determined the carbon dioxide found in the combustion by passing the gas into a bulb apparatus containing baryta water, washing out the contents of the bulbs into a bottle containing air freed from carbon dioxide, and determining the excess of barium hydrate with standard solution of oxalic acid. His process, however, was quite unlike Frankland's in some of its most important features, since sulphuric acid was added to the water before evaporation to decompose the carbonates, and the combustion of the residue, mixed with lead oxide enough to more than neutralize the excess of free sulphuric acid, was burned in a stream of oxygen gas, a determination of the carbon only being obtained, and nitrogen neglected.

Bellamy¶ used hydrochloric acid to render faintly acid the water to be evaporated,

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*Wanklyn and Chapman. Water analysis. A practical treatise on the examination of potable water. 5th ed., by J. A. Wanklyn. London, 1879; 31.

†Anleitung zur Untersuchung von Wasser. 2te Aufl. Bratenschweig, 1874; 98.

‡Jour. Chem. Soc. (Lond.), Jan., 1879; 50.

§Berichte d. deutsch. Chem. Gesellsch. 12; 1906.

‖Landwirthsch. Versuchstation, 10, 516; Zeitsch. für anal. Chem. 8ter Jahrg., 494.

¶Archiv. d. Pharm. [II], 136, 112; from Journ. de Pharm. et de Chim., and Zeitsch. für anal. Chem. 8ter Jahrg., 495.

removed the residue before it had become quite dry to a combustion tube containing a decagramme of potassium chlorate at the closed end, mixing the residue with cupric oxide, carried the carbon dioxide produced in the combustion into a solution of barium nitrate mixed with ammonia and rendered clear by subsidence, filtered off the barium carbonate produced, removed ammonia from it by warming, dissolved in a known amount of standard nitric acid, and determined the excess of free acid left by means of standard ammonia solution. This process also gives, of course, carbon only, without taking account of nitrogen.

Dittmar and Robinson,* starting with Frankland and Armstrong's process before them, and aiming to simplify so as to shorten it, and to bring it within the range of ordinary laboratory appliances, separate the determinations of carbon and nitrogen. For the former, the water, mixed with sulphurous acid, is boiled down to a small volume in a slanting flask, the evaporation completed in a glass capsule on a water-bath, the residue mixed with lead chromate (which was found to require very special treatment to free it from carbon) or cupric oxide, a spiral of copper or silver gauze being placed in front of the mixture, the combustion effected in a current of air from a glass gas-holder charged with dilute caustic soda, and the carbon dioxide, after passing through a solution of chromic acid in 60 per cent. sulphuric acid and a small tube of calcium chloride, absorbed by soda-lime in a small, light tube having a layer of calcium chloride in its exit end. This absorption tube is weighed to one-tenth of a milligramme before and after the combustion. Care must be taken to employ Indian rubber connectors to as small an extent as possible. For the nitrogen, a separate portion of the water is concentrated to a small volume by boiling down without addition in a slanting flask, the vapor given off being condensed and the ammonia in it determined by Nessler's solution; to the concentrated water remaining in the flask the requisite quantity is added of sulphurous acid and ferric chloride, with a little of some material such as potassium sulphate, to give body to the residue, the evaporation completed on a water bath, the residue burned with a mixture of barium and sodium hydrates in a current of hydrogen gas, the ammonia produced from the organic nitrogen collected in highly dilute hydrochloric acid, and the amount of ammonia determined by means of the Nessler reagent. Special precautions are necessary to prevent ammonia from extraneous sources being collected.

Mills,† in examining into the amounts and sources of error connected with the process, finds that a loss of carbon and gain of nitrogen are produced by using for the evaporation of the water a glass dish of 6 inches instead of 3 inches in diameter, as had been proposed by Bischof,‡ and attributes the excess of nitrogen to ammonia taken up from the air in larger quantity with increased surface exposed. He recommends, therefore, the use of a dish not more than 3 inches in diameter. He also proposes a form of apparatus for evaporating the water, of which the chief features are a current of dried and warmed air drawn over the surface of the water, a cover externally cooled by water to promote condensation of the vapor formed within, and a delivery tube, leading from the feed flask, so bent as to retain two long bubbles of air, intended to prevent the water in the flask becoming heated by convection, and to thus delay the application of heat to the water until it reaches the evaporating dish. As one of the reasons for introducing this last arrangement, he says that it is "objectionable to heat the delicate organic matter of waters (and especially of peaty waters) any longer than is strictly necessary," thus by inference admitting the liability of such organic matter to loss or chemical change during the evaporation.

Dupré and Hake§ propose to evaporate the water with addition of phosphoric acid, to burn the water residue in a stream of oxygen, carrying the gas over red-hot cupric oxide in the forward part of the combustion tube, absorbing the carbon dioxide in a long column of baryta water, filtering out and washing the barium carbonate, dissolving it by means of weak hydrochloric acid, evaporating the solution to dryness with addition of sulphuric acid, igniting and weighing the barium sulphate. Minute and rather troublesome precautions are necessary in connection with the filling of the absorption tube, the combustion, the filtering, and the washing of the barium carbonate, in order to avoid the introduction of carbon dioxide from the air or other extraneous source. These chemists also propose to estimate extremely minute amounts of carbon dioxide by the degree of turbidity (observed in a form of colorimeter) produced on passing the gas into a weak solution, of standard strength, of basic lead acetate. They further propose to substitute for the glass dish used to contain the water during evaporation a dish made of thin silver foil, which can be crushed or rolled up without removal of the water residue from it, and introduced into the combustion tube for ignition in the stream of oxygen. It is obvious that these arrangements look only to the determination of carbon, and leave the nitrogen of the organic matter out of the account.

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* Chem. News, July 20, 1877; 26—a paper read before the Chem. Section of the Glasgow Philos. Soc., April 30, 1877.

† Jour. Chem. Soc. (Lond.), Feb., 1878; 57.

‡ Proc. Philos. Soc., Glasgow, 9; 21.

§ Jour. Chem. Soc. (Lond.), March, 1879; 159.

Lechartier,* in view of the difficulties arising from the presence of nitrates, which he affirms cannot be completely decomposed by evaporation with sulphurous acid, proposes that in cases in which these salts are present the carbon shall be determined by combustion of the residue from evaporating one portion of the water with addition of sulphurous acid to decompose the carbonates, while the nitrogen is to be obtained by a separate combustion of the residue from another portion of water with addition of magnesia to expel ammonia from any ammoniacal salts present, the quantity of the nitrates being determined on still a third portion, and the corresponding amount of nitrogen subtracted from that obtained by combustion. Thus the actual quantity of nitrogen obtained by the original process of Frankland represents that due to the organic matter plus the ammoniacal salts present in the water residue, the nitrogen of the nitrates being assumed to have been expelled; while on the plan recommended by Lechartier the nitrogen obtained is that of the organic matter plus the nitrates, that due to ammonia and ammoniacal salts having been removed.

Pellet† has used a method based on the same principle with that of Lechartier, but modified as follows: The nitrogen of the nitrates is determined in one sample of the water; another sample is evaporated with addition of magnesia to expel ammonia, the dry residue weighed, and such a portion of it as shall not contain more nitrates than the equivalent of .20 or .25 grain of potassium nitrate is ignited with soda-lime to which starch has been added, the ammonia produced being received in standard acid, and the unsaturated acid determined by caustic soda of standard strength. As the result of this combustion the nitrogen corresponding to the organic matter plus nitrates is obtained, and this, calculated for the whole amount of water residue, gives, by subtraction of the nitrogen due to nitrates, that belonging to the organic matter.

M. W. Williams‡ proposes to expose the water to the action of the "copper-zinc couple" of Gladstone & Tribe§ by digesting 1,200 or 1,300 c. c. on the copper-coated zinc foil in a glass-stoppered, completely filled bottle, at about 24° C., for several hours. The nitrogen of the nitrates is converted into nitrites, and subsequently into ammonia, and the completion of the process is ascertained by testing samples from time to time for nitrites. When these have disappeared the remainder of the water is poured off from the "couple," and allowed to stand at rest in a tall cylinder until any suspended particles of copper or oxide of zinc have subsided. A liter of the water, or some other definite amount, is decanted into a clean retort, and distilled, with the addition of a drop or two of a concentrated solution of sodium carbonate, or a little fragment of pure lime, until reduced to 200 or 100 c. c. The ammonia in the distillate may be quantitatively determined for the purpose of calculating the nitrogen of the nitrates. The concentrated residue is treated with a little phosphoric or sulphurous acid, just enough to decompose any carbonates, boiled briskly for a few minutes, washed out into a small hemispherical basin, and evaporated to dryness on the water-bath. The residue thus obtained, containing now only the nitrogen of the organic matter, that of the nitrates, nitrites, and ammoniacal salts having been removed, is ready for combustion by Frankland's method. Williams claims that his new method is quicker and less troublesome than that of Frankland, and is "comparatively free from objection on the score of its destructive action on the organic matter."

Perkins‖ proposes, as a simplification of Dittman and Robinson's method (see above) for determining carbon, to charge the forward end of a combustion tube with a mixture of potassium chromate and dichromate and cupric oxide, introducing behind this a platinum boat containing the water residue. The combustion is conducted in a stream of air drawn by an aspirator through potash bulbs to remove carbon dioxide and the amount of this gas produced from the organic matter is determined by the change of weight of a soda-lime tube, preceded by a calcium chloride tube to dry the gas, and followed by a little guard tube also containing calcium chloride to retain any moisture carried off from the soda-lime. Of course, this plan makes no provision for the nitrogen, but looks only to the gravimetric determination of the carbon. In dealing with such minute quantities as are concerned in water analysis, it may well be doubted whether any gravimetric processes, even those which as in the plan of Dupré and Hake, magnify the weight to be determined, are as much to be relied upon as the delicate methods of gaseous volumetric analysis, or such sensitive colorimetric indications as are afforded by the Nessler reagent.

There could be no doubt that the Frankland combustion process should be included amongst those to be examined, and particularly in reference to the most important claim made in its favor, namely, that it alone affords positive, not merely comparative or approximate results. It is now pretty generally recognized that, as stated by

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*Comptes rendus, 89; 231. Ann. de Chim. et de Phys. [5]; 19; 257.

†Comptes rendus, 89; 523.

‡Jour. Chem. Soc. (Lond.)—April, 1881; 144. The use of the copper-zinc couple for the *determination* of nitrates in water is in reality of earlier date—see besides Professor Thorp's use of the method papers by Prof. A. R. Leeds, in Proc. Amer. Chem. Soc., II, 4, 151, and Zeitschrift für anal. Chem., 17; 276.

§Proc. Roy. Soc. (Lond.), 20; 218.

‖Analyst (1880)—5; 124—quoted in Jour. Chem. Soc. (Lond.), April, 1881; 197.

the principal author of this method, "no process is known by which the actual weight of organic matter dissolved in water can be ascertained," but he claims that "the amounts of carbon and nitrogen contained in that organic matter can be accurately determined, and they furnish a quantatitive measure of the extent of the organic contamination. This information, however, can only be obtained by means of ultimate analysis, *i. e.*, the combustion of the residue left on evaporating the water.* It was also proposed to see how far the samples examined would support the claim † that for surface water the ratio of organic carbon to organic nitrogen gives trustworthy evidence of the organic matter present being derived from an animal or vegetable source respectively.

PERMANGANATE PROCESS.

The first person to make use of the discolorization of a standard solution of potassium permanganate as the means of estimating the organic matter in water seems to have been Forchhammer,‡ who as early as 1849 or 1850 published an account of his mode of precedure, which consisted merely in adding a solution of the permanganate of known strength, without any other reagent, to a measured amount of the water to be examined, until the liquid had acquired a faint permanent tinge from the purple salt, and noting the quantity of the latter used. The amount was assumed to be in some sense proportional to that of the organic matter present, the oxidation of which had caused the reduction and consequent discolorization of the permanganate. Of course, the absence of nitrites, ferrous salts, or other inorganic substances capable of discolorizing the permanganate must be ascertained, or their amount determined and allowed for. It was afterwards ascertained that more uniform results could be obtained, and with less expenditure of time, by causing the permanganate to act in the presence of free acid or free alkali, and that the action might also be expedited by elevation of temperature.

Three principal forms of the process, as it has been used in more recent years—namely, those commonly associated with the names of Kubel, Schulze, and Tidy—chiefly demand notice.

Kubel§ acidifies the water to be examined with dilute sulphuric acid, and adds such a (precisely measured) quantity of dilute aqueous solution of potassium permanganate that the liquid remains colored strongly red, and retains its color even after heating to the boiling point, and continuing the boiling for about five minutes. A sufficient (measured) quantity of standard solution of oxalic acid to discolcrize the liquid is now added, and finally the permaganate is dropped in from a burette until a faint pink tint, permanent on stirring, is observed. The quantity of permanganate consumed in oxidizing the organic matter is obtained by subtracting from the whole quantity used that which is equivalent to the oxalic acid added.

Schulze‖—as also Trommsdorff,¶ who examined this method soon after it was brought forward—renders the water alkaline by means of caustic soda, adds a known amount of standard permanaganate solution, heats to the boiling point for about ten minutes, allows to cool to 50° or 60° C., adds dilute sulphuric acid in moderate excess, and then it being observed that at this stage the liquid is distinctly red, a measured amount of standard oxalic acid solution, shaking and gently warming if necessary until complete discolorization takes place. The standard solution of permanganate is now cautiously added from a burette, until a faint pink tinge is produced which does not disappear for at least five minutes. From the whole quantity of permanganate used is subtracted that which is equivalent to the oxalic acid added, and the remainder represents that consumed in the oxidation of the organic matter.

Tidy,** adopting and accurately defining the details of the process as used by Letheby,†† and as in the main suggested by Harcourt,† acidifies the water with a definite amount of dilute sulphuric acid, adds a definite amount of standard solution of permanganate, sufficient to leave an excess, as shown by the color, at the end of the time the action is allowed to continue, which time is an hour for one specimen thus treated, while another specimen, with precisely similar additions, is allowed to stand for three hours—both at the ordinary temperature of the room.

At the expiration of the allotted time, to each specimen are added a couple of drops of a pretty strong solution of potassium iodide, from which as much iodine is set free as corresponds to the permanganate or permanganic acid remaining undecomposed in the liquid. The amount of iodine so liberated is determined by adding from a burette a standard solution of sodium thio-sulphate (the strength of which is ascer-

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* Frankland—water analysis for sanitary purposes, p. 45.
† *Ib.*, p. 83.
‡ L'Institute, 1849; 383. Trans-Roy, Danish Soc. 5th ses.; Phys. and Math. Lect.; 2.
§ Kubel: Anleitung zur Untersuchung von Wasser. Braunschweig; 1866.
‖ Kubel u. Tiemann: Anleitung zur Untersuchung von Wasser, 2te Aufl., Braunschweig; 1874.
¶ Zeitschrift für anal. Chem., 8ter Jahrg.; 350.
** Jour. Chem. Soc. (Lond.), Jan., 1879; 67.
†† Jour. Chem. Soc. (Lond.), *loc. cit.*, and May, 1865; 128.

tained by a blank experiment made at the same time with pure distilled water and the same reagents) until the yellow color of the iodine has very nearly disappeared, dropping in a little clear starch water, and continuing the addition of the thio-sulphate until the blue color of the starch iodide just disappears. From the amount of sodium thio-sulphate used the quantity of free iodine is obtained, from this the quantity of unreduced potassium permanganate, and from this, by subtraction from the total quantity of the same salt used, the quantity which has gone to oxidize the organic matter of the water.

The permanganate process has been employed by others with some slight modifications of detail.

Thus Mounier * first heated the water under examination to 70° C., then added sulphuric acid, and finally the standard permanganate solution until a distinctly permanent coloration was produced, noting the volume used.

Angus Smith† operated at common temperature, but preferred to note separately the quantity of permanganate decolorized at once when used alone, and that decolorized after standing a short time with addition of sulphuric acid.

W. A. Miller ‡ acidified the water at common temperature, declaring against the use of artificial heat, using either sulphuric or hydrochloric acid,§ and added the permanganate in successive small doses until the last addition remained sensibly unaltered after he lapse of half an hour, or else added an excess of permanganate at once, allowed the whole to stand for three hours, and then destroyed the residual permanganate by a reducing agent, preferring the use of sodium thio-sulphate, with potassium iodide and starch, as suggested by Mr. Harcourt.

Wanklyn has proposed ‖ (and protected by a patent!), under the name of "the moist combustion process," the following modification of the method of Schulze and Trommsdorff: Potassium permanganate, in known quantity, and caustic potash are added to the water, which is then distilled in a retort down to about a tenth of its original volume. It having been ascertained that the liquid is still red, it is acidified with sulphuric acid, a known volume of standard solution of ferrous sulphate more than sufficient for complete decolorization is added, and finally standard solution of permanganate is dropped in from a burette until a faint permanent pink tinge is produced. Of course the total amount of permangate used, less that decolorized by the ferrous sulphate, gives the amount reduced by the organic matter.

The potassium permanganate process, with no important difference in details from those above described, has also been advocated and used by Hervier,¶ Condy,** Woods,†† Schacht,‡‡ Schrötter,§§ Letheby ‖‖ (in periodical examinations of the London water supply), and others.

This process appears to be pretty extensively used at the present day, especially, it would seem, on the continent of Europe. Amongst the criticisms which have been made of it the following are probably the most important:

iMiller¶¶ points out that the quantity of permanganate required will vary with the krnd of organic matter, so that the bulk of solution decolorized will not necessarily be p oportioned to the weight of the organic substance present; that water containing a kind of organic matter absolutely or comparatively harmless may decolorize as much permanganate or more than another water containing a dangerous amount of some septic poison; and that some inorganic substances are liable to occur in water which are capable of decolorizing the permanganate, as for instance nitrites. He disposes of the first and second of these objections, however, by remarking that they apply with even greater force to other processes previously employed, and that "it is not improbable that the substances most readily oxidized are just those most likely to be injurious in their effects upon those who drink the water; and in regard to the third objection says that the presence of nitrites can be ascertained by their appropriate reactions, and by the fact that their action on the permanganate will be almost instantaneous.

Frankland and Armstrong, in their original paper on the combustion process,*** condemn the use of the permanganate solution, giving the results of some experiments made with it upon distilled water to which had been added known quantities of nine

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* Comptes rendus, 50; 1084.

† Mem. of Lit. and Phil. Soc. of Manchester, Chem. News; July 16, 1869; 27.

‡ Jour. Chem. Soc. (Lond.), May, 1865; 121.

§ Determinations made with permanganate in a solution containing hydrochloric acid are incorrect in principle on account of the reaction on each other of these two substances, liberating chlorine, but under the (Lowenthal and Lenssen: Zeitschrift f. anal. Chem.; 1; 329) conditions of Miller's experiments, the error from this cause would probably be but trifling.

‖ Wanklyn: Water Analysis; 5th ed.; 1879; 55.

¶ Comptes rendus, 51; 954.

** Jour. Chem. Soc. (Lond.), Jan. 1879; 67. Chem. News, July 16, 1869; 28.

†† Jour. Chem. Soc. (Lond.), [2] 1; 62.

‡‡ Archiv für Pharm. [2]; 135; 10.

§§ Wien. Acad. Ber., 41; 562.

‖‖ Jour. Chem. Soc. (Lond.), Jan., 1879; 67.

¶¶ Jour. Chem. Soc. (Lond.), May, 1865; 123.

*** Jour. Chem. Soc. (Lond.), Mar. 1868; 81.

different kinds of organic matter (several of them harmless in themselves, and not very likely to occur in ordinary drinking water), the action on those of the permanganate being very incomplete and very different in extent, the figures showing the fallacy of Dr. Letheby's practice of counting the organic matter present as represented by eight times the weight of the oxygen withdrawn from the permanganate. The rapid decoloration of the solution, even, is not considered to afford trustworthy evidence of "the presence of organic matter in actual putrescence, and consequently in its most dangerous condition."

Frankland, in his separate little book on water analysis,* of later date, speaks more favorably of the permanganate process, saying that "with waters of a similar character the oxygen process furnishes a ready and fairly efficient means of comparing their relative organic purity, but it is not trustworthy where waters of heterogeneous origin are submitted to it." He says, "the objections to the Forchhammer process are, first, that its indications are only comparative and not absolute; and, secondly, that its comparisons are only true when the organic matter compared is substantially identical in composition."

Angus Smith,† while attaching but little value to the total amount of permanganate decolorized, lays much stress on the amount decolorized within a short time, after deduction for nitrites, or, if present, considering that thus a measure is obtained of the "putrid matter" present.

Kubel and Tiemann‡ admit that the amount of permanganate decolorized by a water is no true measure of the quantity of organic matter it contains, but consider from their own experience that a real relation exists between the amount of oxygen withdrawn from permanganate, and the injurious character of the water depending on its organic matter; expressing, however, regret that the collection of data from which to form an opinion on this point is very incomplete. They point out as the special merit of the process that it deals with the water itself, not the residue of evaporation, so that volatile as well as non-volatile organic matter is taken account of. They insist on the necessity of carefully and uniformly observing the precise conditions of experiment if comparable results are to be obtained. They admit the use of either Schulze's or Kubel's modifications of the process, showing by a series of experiments that the former gives a little higher results in consequence of the permanganate being applied successively both in alkaline and acid solution, but on the whole rather prefer Kubel's plan, on account of its greater simplicity, and in view of the additional amount of organic matter attacked by Schulze's method being oxidized with greater difficulty than the rest, and therefore probably of less importance on sanitary grounds. They note that a source of error may be found in the oxidation by permanganate of ammonia, if present in large quantity, to nitrous, and subsequently nitric acid, and advise in such case removal of the ammonia by evaporation before the oxidation experiment is begun.

Tiemann and Preusse§ prefer Kubel's modifications of the process to those of Schulze and Tidy, on the grounds that it is the simplest of the three and most free from sources of error.

Fischer‖ admits that the permanganate results are merely comparative as to the amount of easily oxidizable organic matter present, but says that, in the absence of a better method, that of Fluk having no superiority, and in connection with microscopic examination it may very well serve as a measure of the contamination.

Tidy claims a high degree of value for the process as conducted by him, on the grounds of—

1st. Dealing with the water in its original state, and without the application of heat.

2d. Results of great constancy and extreme delicacy being obtained.

3d. A sharp distinction being drawn between "the putrescent or readily oxidizable organic matter, which is the more likely, to use Dr. Frankland's term, to be 'pernicious,' and the non-putrescent, or less readily oxidizable matter, which is probably harmless, so far as its action on the human body is concerned."

4th. That the only inorganic constituents of natural waters capable of interfering with the use of permanganate can be easily detected, determined, and corrections made for their effects.

5th. That while, as the result of this process, a harmless water might be unfavorably reported on, a bad water would never be reported upon favorably.

6th. That the permanganate and combustion processes give, in general, closely concordant results (proved by comparison of a long series of examinations of London water supply—all the specimens, it is to be noted, of, on the whole, much the same general character), while the results yielded by the albuminoid ammonia process are often at variance with both.

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* Water Analysis for Sanitary Purposes, London, 1880.
† Member of Lit. and Phil. Soc. of Manchester. Chem. News, Sept. 3, 1869; 112.
‡ Anleitung zur Untersuchung von Wasser, 2te April, 1874; 99 and 108.
§ Berichte d. deutsch. chem. Gesellsch., 12; 1906.
‖ Die chem. Technologie d. Wassers, Braunschweig, 1880; 123.

Other points in favor of the process are noted, but these are the most important. As regards the last, it should be observed that the mere fact of the results of two processes agreeing with each other, while those of a third process differ from both, is very far from satisfactory proof that the two former are right and the last wrong. What is really wanted is independent evidence as to the wholesomeness or unwholesomeness of a water, in order to compare them with the results obtained by each method of chemical examination. The classification of waters as "(1) of great organic purity; (2) of medium purity; (3) of doubtful purity; (4) impure" is presented, with a remarkable lack of any definite evidence as to the real sanitary character of the waters examined, with which this classification might be compared. The same remark applies to the numerous results obtained by the combustion process.

It was clear that the permanganate process ought to be examined. As one of its chief merits, perhaps its strongest claim to consideration, consists in its applicability to the water in its original state, so that the organic matter may be assumed to be unaltered in nature or amount by evaporation or other violent treatment, it was thought that the modification now generally spoken of as Tidy's should be that chosen for special study, since this involves no artificial heating. It was arranged, however, that Kubel's modification, employing a boiling temperature, should also be applied to the same series of specimens, thus securing a comparison of the results yielded by the two. It was planned that not only should this process be tested by its application to sundry solutions of definite chemical substances, including some of the products of putrefaction, but that by examining the results it should yield with various natural waters of known sanitary history, and with various specimens of pure water artificially polluted with known forms of vegetable and animal refuse, some test should be made of the claim that permanganate specially attacks easily oxidizable, hence decomposing or putrescent, hence specially pernicious forms or organic matter, and, as is strongly hinted by Tidy, enables us to decide with probability as between animal and vegetable impurities.

ALBUMINOID-AMMONIA PROCESS.

This method, aiming at an estimation of the albuminoid and other forms of nitrogenous organic matter in water, was originally brought forward and used by Wanklyn, Chapman, and Smith. In their first paper * on the subject the authors proposed that the water should be distilled, first with addition of sodium carbonate, secondly with further addition of caustic potash, and finally with addition (to the same sample) of potassium permanganate. In the successive distillates ammonia was to be determined by the use of Nessler's reagent. It was stated that the first distillate contains the ammonia originally present in the water, plus that drived from the destruction of urea and allied compounds; the second distillate somewhat less than one-third of the ammonia corresponding to the nitrogen of albumen, gelatine, and allied substances present; and the third distillate the remaining two-thirds or more of the ammonia referable to the same source.

A subsequent paper by Wanklyn † gives the results of some experiments made to obtain proof of the correctness of the new method of determining organic nitrogenous matters in water. In these experiments the second and third distillations mentioned above were generally united; that is to say, after distillation with sodium carbonate the caustic potash and the permanganate were added to the water at the same time, and the distillation proceeded with; sometimes the previous practice was adhered to. It is stated that the process as thus conducted does not yield ammonia corresponding to the whole amount, but only to two-thirds, or "at any rate a constant fraction" of the whole amount of nitrogen present; but that, if the boiling with caustic potash be continued to *dryness*, the total nitrogen, or almost the total nitrogen, in the albuminoid material treated may be obtained in the form of ammonia. Such distillation to dryness is pronounced inconvenient, and not to be recommended in practice.

The results of further experiments are given as to the amount of ammonia obtained from urea during the first distillation with sodium carbonate, showing that the evolution of ammonia is slow and imperfect, and it is stated that the method is not practicable with pure urea dissolved in pure water, but that in the presence of albuminoid matter the urea is more easily attacked. It is stated that the boiling of urea with potassium permanganate and caustic potash oxidizes a large proportion of the urea, so as to convert much of its nitrogen into free nitrogen or nitrates. In reference to this last point, it is remarkable that Wanklyn, in a foot-note, records the results of two experiments, in which urea was distilled with sodium carbonate, caustic potash, and potassium permanganate, all added together, and which yielded about 30 per cent. and 22 per cent., respectively, of the theoretical amount of ammonia, *i. e.*, of the amount corresponding to the total nitrogen present; yet subsequently and

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* Jour. Chem. Soc. (Lond.), Sept., 1867; 445.
† Jour. Chem. Soc. (Lond.), Dec. 1867; 591.

repeatedly he affirms,* in the most positive way, that urea is an exceptional substance, in that, when heated to the boiling point with caustic potash and potassium permanganate, it "evolves none of its nitrogen as ammonia." This assertion has been extensively copied by other writers, and its accuracy, as far as I know, has not been called in question.

Another paper, by Wanklyn and Gamgee,† gives the results of experiments on the oxidizing effect of strongly alkaline permanganate heated with urea, ammonia, and acetamide, respectively, in sealed tubes, to temperatures considerably beyond the normal boiling point of water. No ammonia, or mere traces, resulted, and hence probably the origin of the often-repeated statement as to urea not giving any of its nitrogen as ammonia in the ordinary form of the albuminoid-ammonia process, notwithstanding that the results of two experiments, and only two, at 100° C. (pretty clearly the same two above quoted from the previous paper) are given, which are far from supporting this assertion.

A few months later, a paper by Wanklyn, Chapman, and Smith,‡ mainly devoted to criticism of Frankland and Armstrong's combustion process, contains a table of results obtained with natural waters by the albuminoid ammonia process, intended to exhibit the constancy of these results as derived from various quantities of water operated on. In this paper it is reiterated that reliance is placed by the authors "simply upon the constancy of the ratio between the amount of albuminoid substance in the water and the quantity of ammonia produced."

Still later, a paper by Wanklyn and Chapman§ furnishes the results of the application of the process in question to a number of nitrogenous organic substances of definite composition, most of these being amines (one or two amides), and natural alkaloids. The general conclusion arrived at is that the action of the alkaline permanganate is in each case "perfectly definite," some substances evolving the whole of the nitrogen as ammonia, others one-half, others one-third or one-fourth only, while picric acid gave none at all. It is again stated that nitro-compounds, urea, and potassium ferro-cyanide fail to yield ammonia by treatment at 100° C. with the strongly alkaline permanganate.

The details of this process have been described by its authors with ample fullness in a small book‖ specially devoted to the subject of water analysis, and the process itself, which is, in part at least, recommended to most people by its simplicity and the ease with which it may be carried out, has come into very common use in England, and is, as far as I can learn, much more employed than any other method in America. It has, however, been the subject of much criticism, especially from the following sources:

Frankland and Armstrong¶ object to the process, that it does not afford a measure of the organic matter present, nor of the nitrogen thereof, neither the whole amount of nitrogen, nor a constant fraction of it, being evolved as ammonia according to experiments made by themselves, some with known amounts of alkaloids of definite composition, some with natural waters examined by both the albuminoid-ammonia and combustion processes. Frankland, in another paper,** also remarks that "the total immunity of urea from the reaction is peculiarly unfortunate, because it is practically impossible to estimate the urea in a good potable water to which fresh urine has been added, by boiling with sodic carbonate; and yet the estimation of the nitrogen of urea, not to speak of its carbon, is of the utmost importance in the investigation of waters polluted by sewage."

Further, that the albuminoid-ammonia process cannot be used to indicate either the presence or the proportion of *albuminoid* as distinguished from other nitrogenous organic compounds, peaty water, for instance, in which it is assumed that albuminoid compounds cannot be present, yielding a large proportion of its nitrogen as so-called albuminoid-ammonia. He comes to the conclusion that this process is entirely useless in the examination of waters for sanitary purposes.

Kubel and Tiemann†† say that their own experiments, the extent of which is not indicated, have only given negative results, since in no case have they been able to establish a clear connection between the amount of ammonia evolved by this treatment and the quantity or character of the nitrogenous organic matter present in the water.

Mills‡‡ says of the process that it is "simple and elegant, and will probably form a leading feature in our future methods, for it admits of graduation, and may serve to

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*Jour. Chem. Soc. (Lond.), May, 1868; 170, 171. Wanklyn and Chapman. Water Analysis, 5th ed. Lond., 1879; 131, 132, 167, 168.

†Jour. Chem. Soc. (Lond.), Jan. 1868; 25.

‡Jour. Chem. Soc. (Lond.), April, 1868; 152.

§Jour. Chem. Soc. (Lond.), May, 1868; 161.

‖Wanklyn and Chapman Water Analysis; a practical treatise on the examination of potable water, 5th ed., by Wanklyn, London, 1879; 28.

¶Jour Chem. Soc. (Lond.), March, 1868; 97.

**Jour. Chem. Soc. (Lond.), June, 1876; 847.

††Anleitung zur Untersuchung von Wasser, 2d Aufl.; 1874; 101.

‡‡Jour. Chem. Soc. (Lon.), Feb. 1878; 58.

distinguish one impurity from another. Unfortunately, however, it deals with bodies at present unknown, in a manner of which we are ignorant; its results, therefore, admit of no precise interpretation, and (as has been justly remarked, Sutton's Volumetric Analysis, 3d ed., p. 345) can aid only to distinguish a bad water from a good one."

Tidy* quotes the above-noted objections; thinks the importance of that based on the variable yield of nitrogen as ammonia by different substances may be overrated, as the main question is whether, on the whole, the yield of albuminoid ammonia keeps pace with the purity or impurity, as the case may be, of waters examined, and answers Mills's accusation against the process, that it yields results which admit of no precise interpretation, inasmuch as it deals with bodies at present unknown, by remarking that this objection, he (Tidy) is afraid, applies more or less to all processes. He then, however, presents some very distinct objections of his own, namely:

1. That he believes it to be practically impossible to prepare an alkaline solution of potassium permanganate absolutely free from ammonia. Hence, he has always found it necessary to estimate the quantity of ammonia in the permanganate solution, and to deduct this from the total quantity obtained in the actual experiment.

2. That he considers it extremely difficult to exhaust, or bring to an end, the action of the alkaline permanganate, finding that if distillation be carried on until ammonia ceases to be evolved, and the apparatus be then set aside for a few hours, carefully guarding it from contamination by the laboratory atmosphere, on renewing the distillation, albuminoid ammonia may be obtained again, and even in quantity equal to, if not greater than, the former product.

3. That on several occasions he has noticed an actual disappearance of ammonia, the total ammonia yielded by a given quantity of alkaline permanganate, plus a sample of water, turning out less than the quantity known to have existed in the alkaline permanganate alone. He suggests oxidation of the nitrogren as a probable cause for this.

4. That he doubts whether depth of tint in a solution (as in the use of the Nessler reagent) can ever be made the basis of accurate quantitative measurement, but that at any rate there is a certain error of observation connected with each experiment, which error varies with different eyes, and, as the color in three or four distillates has to be estimated for each complete experiment, there will be three or four of the errors in question, and further, that these three or four errors will be multiplied by 2, since Wanklyn directs that the original result, stated in milligrams, and obtained from the treatment of half a liter of water, shall be multiplied by 2, in order to express it in the form of milligrams per liter, or parts per million. Tidy says: "Here, then, is a source of enormous error."

But it looks as if the multiplication of errors belongs rather to the criticism than to the process. The estimation of ammonia by means of the Nessler reagent involves not an absolute judgment of the depth of tint of a single liquid, but a comparison of such tint with that produced by a standard solution of ammonia of known strength. The two liquids of similar character being seen at the same time with the same eyes, the error referred to above can only consist in a want of sensitiveness on the part of the observer for minute differences in depth of tint; there is no reason that the *direction* of this error should be constantly, or more frequently, on one side of the truth rather than the other; hence the consequence of three or four estimations being made instead of one only is a probability that the error of the final results will be less instead of greater than the error of a single observation. And surely there is no real change produced in the ratio of the error to the whole quantity determined by representing the latter on the basis of parts in a million rather than parts in five hundred thousand; an error of .01 on .25 parts of ammonia in 500,000 of water represents exactly the same degree of accuracy as an error of .02 on .50 in 1,000,000.

A fifth objection refers, not to the process itself, but to the degree of importance attached by Wanklyn to the amount of free ammonia in interpreting results. In another place† objection is made to the general interpretation of albuminoid ammonia as indicative of the degree of impurity of the water.

Tidy sums up by saying of the albuminoid-ammonia process in general that it gives fairly concordant results when uniformly conducted; that is, with solutions made by the same person, with the same hands to manipulate, and the same eyes to judge the tint-depths. But he considers this almost of itself a fatal objection to its general employment in water analysis, since, in the light of his objections, "every man must be a law unto himself, whilst one man's law is no one else's law. Hence comparisons are rendered impossible." (It is to be noted here that Tidy's own modification of the permanganate process involves also determination of tint-depth in deciding upon the close of the reaction, and in more difficult form for the eye than that of judging whether two solutions are alike or different; further, for reasons given above, the difficulty arising from individual peculiarity of "colorsight" is simply one of greater

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* Jour. Chem. Soc. (Lond.), Jan., 1879; 57.
† P. 96.

or less sensitiveness,* not one of constant error in a given direction; hence there is no reason that results obtained by one observer may not be compared with those of another, though the former may deserve to have greater or less weight attached to them than the latter.) Tidy considers that the process in question may, as a rule, be used to discriminate between a water of excellent quality and one exceptionally bad, but that in more delicate and difficult cases, involving water of intermediate character, this process "absolutely and entirely fails."

Tiemann and Preusse† consider the process simple and easy, and capable of giving comparative results when the instructions of the inventors are closely adhered to. Small portions of volatile organic matter may, they think, escape before the addition of the alkaline permanganate. They also find it not easy to obtain this solution free from ammonia. Examining by this process sundry substances of definite composition, they find that the ammonia evolved is always less than that required by theory; but in the case of substances obtainable by the putrefaction of albuminoid matter (such as leucine, tyrosine compounds, &c.), the quantity of ammonia very nearly approaches the theoretical amount. As with the combustion and permanganate processes, so with this, the results do not afford an absolute measure of the total amount of organic matter present, and in this respect the results obtained from different samples of water are comparable only on the assumption that the mixtures of organic substances in the different waters are similar.

The extensive use made of the albuminoid-ammonia process suffices of itself to decide that it should be included in the present investigation. It was proposed to notice particularly such evidence as might be obtained bearing on certain special claims made in its favor—namely, that the ammonia obtained by distillation with alkaline permanganate, though not representing the whole of the nitrogen present, does represent a definite fraction of that existing in particular substances, that this process may be used to discriminate between different classes of nitrogenous organic matter, as urine, vegetable matter, &c., and that it affords special indications of really dangerous forms of organic matter.

SUBSIDIARY DETERMINATIONS TO BE MADE.

It having been decided that the three main subjects for examination were to be—(1) the combustion process of Frankland; (2) the permanganate process of Tidy, with secondary notice of Kubel's modification; (3) the albuminoid-ammonia process of Wanklyn, it became evident that, for the purpose of fairly discussing the results to be obtained by each, it would be necessary to add to these the determination of certain other points in regard to the waters examined, such as are taken into account by the respective authors of the processes in interpreting the figures they yield. After careful consideration of what would be needed, it was settled that the following points should be included in the examination of each water:

a. General physical character—clearness or turbidity, color, odor, &c.
b. Amount of total solid matter.
c. Amount of nitrogen of nitrites.
d. Amount of nitrogen of nitrates.
e. Amount of ammonia, as such, or in ammoniacal salts—"free ammonia" (of Wanklyn).
f. Amount of chlorine of chlorides.
g. Amount of the several dissolved gases—carbon dioxide, oxygen, nitrogen.

Although but little importance for sanitary purposes is now attached to the determination of the dissolved gases, *per se*,‡ it yet certainly contributes an interesting, and in some cases, instructive, feature to the general history of a water, and it was thought that the relative proportions of dissolved oxygen and carbon dioxide might prove to be of importance in connection with the results afforded by the permanganate process.

One other point, it was decided, should be noticed—namely, the effect produced on addition to each water of a solution of tannin. This resolution was based on the recent conclusion of Kämmerer,§ that tannin produces precipitates of gelatine-like material in waters polluted by decomposing animal matter, Kämmerer regarding tannin as "a true group-reagent" for a large number of bodies, and especially those passing most readily into a state of putrefaction.‖ Hager¶ also obtained precipitates

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* The range of uncertainty attaching from this cause to any particular observer's results may be easily ascertained by experiments on a series of weak ammoniacal solutions of definite degrees of strength prepared by another person and handed, with arbitrary distinctive marks only to the observer in question.

† Berichte d. Deutsch Chem. Gesellsch, 12; 1906.

‡ For recent experiments in this direction, see Weyl and Zeitler—Zeitschr., phys. chem. 5; 10.

§ Journ. f. prakt, chem. [N. F.], 14; 322. Bouchardat had previously used a watery infusion of galls, and Fauré, tincture of galls, to detect animal products of decomposition.

‖ In more recent experiments on the water of the Pegnitz above, in, and below Nüremburg, Kämmerer obtained no tannin precipitates. Jahresb. d. agric. chem., 1880; 66.

¶ Pharm. Centralhalle, 18; 294. Hager's actual experiments were made in Berlin in 1866, during the prevalence of Asiatic cholera.

with tannin in suspected waters, but attributes them to the deposit of certain algæ. Very little importance was attached to this point, but, as attention to it involved but little trouble, it seemed to be as well to include it in the general programme.

It was not thought necessary to examine the "hardness," nor the nature and amount of the individual saline constituents of the various specimens, since, although these are matters of general sanitary interest, their bearing is too remote on the main object of this inquiry—namely, the determination of organic matter and substances related to it.

It was held to be very desirable that each water taken for chemical treatment should also undergo careful microscopic examination in the hands of a competent naturalist, and on consulting in regard to this part of the work Professor H. Newell Martin, of the Johns Hopkins University, Baltimore, he most kindly offered to take charge of it himself. He also suggested that a series of "culture experiments," in regard to the development of bacterial and other low organisms, should be made with the various water samples also under his charge.

The noteworthy results obtained two or three years ago by Emmerich* from experiments made, partly on himself by swallowing, and partly on the lower animals in the same way, and by subcutaneous injection of water grossly polluted with offensive, decomposing, and supposed pernicious forms of organic matter, led to a desire that some of these experiments should be repeated with the waters to be examined for the purposes of this report. While Emmerich found that water usually considered unwholesome and even dangerous might be drunk with impunity by a person in health, nay, that apparently unretarded recovery from previously-existing gastric catarrh and gastro-enteritis took place during the daily use of such water, he nevertheless produced fever and death in the lower animals experimented on by subcutaneous injection of stronger, watery solutions of decomposing organic matter, or of the concentrated residues from the evaporation on a water-bath of polluted waters. He formulates and emphasizes, as the practically applicable result of his research, the following rule:

"If the drinking water under examination itself, or if the product of its concentration,† injected beneath the skin of an adult rabbit to the extent of 40 to 80 c. c., produces neither a rise of temperature‡ (of more than 1° C.), lasting for a considerable time, nor finally death, this water contains no putrid substances, no substances injurious to health, or, at most, contains such only in such minute quantity as not to be worth attention."

Professor Martin was kind enough to undertake the addition to the biological side of our research of a series of experiments on rabbits conducted in accordance with these ideas of Emmerich, using the various waters to be chemically and microscopically examined, after they had been severally concentrated by evaporation at a low temperature.

PERSONNEL OF THE LABORATORY STAFF TAKING PART IN THE RESEARCH.

It was obviously important, in order to gain any trustworthy new information in regard to the different processes to be examined, that the actual execution of the laboratory work should be in competent hands, so that any defective results that might be obtained might not be fairly ascribed to the demerits of the experimenters rather than to those of the methods used by them. Hence it is proper that a few words should be said of the gentlemen in whose hands the laboratory experiments were carried out.

It being proposed that the chemists who were to apply the three principal processes—"combustion," "permanganate," and "albuminoid ammonia"—should work quite independently of each other, permission was kindly given by Prof. Ira Remsen, of the Johns Hopkins University, Baltimore, with the assent of Dr. Gilman, president of the university, that one of these processes should be carried out in the chemical laboratory of that institution; the laboratory equipment existing at the office of the National Board of Health, in Washington, was made available for a second, and the third was provided for in the laboratory of the University of Virginia.

On the recommendation of Professor Remsen, Dr. M. S. Southworth at first took charge at Baltimore of the combustion process; but much delay occurred, partly owing to the necessity of importing the Frankland special apparatus from England, and a previous engagement as professor in Williams College, Massachusetts, obliged Dr. Southworth to give up the undertaking when but a few preliminary analyses for practice had been made.

His place was taken by Mr. Wm. A. Noyes, B. S., also recommended by Professor Remsen. Mr. Noyes is a native of Iowa, and graduate, in 1879, of Iowa College, in

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* Zeitschrift für Biologie, B. 14, st. 4, 563.

† The concentration seems to have been carried to about one-fifth or one-sixth of the original bulk of the water.

‡ In some of the experiments notable *fall* of bodily temperature occurred.

that State. His connection with the college included not only a student course of two years in analytical chemistry, but an additional year spent in the position of assistant in chemistry, to which he was called soon after his graduation. During this third year he worked largely at nitric acid determinations, and made a few water analyses by Tidy's process. In the autumn of 1880 he was appointed to take general charge of the chemical department of the college during the absence of the regular professor. In January, 1881, he went to the Johns Hopkins University, spent two months on organic chemistry, and then took charge of the work for the National Board of Health. In June he received an appointment to one of the graduate scholarships in the university, which he still holds. Mr. Noyes has proved himself to possess a thoroughly intelligent grasp of the principles on which he has had to work, and at the same time has shown great dexterity and manipulative neatness. As far as the alleged difficulty of managing Frankland's process is concerned, it may be safely affirmed that it was in this research tested by hands of much more than average laboratory skillfulness. Working first for a short time with Dr. Southworth, and afterwards carrying out by himself an extended course of experiments for practice, Mr. Noyes remained in charge of the combustion process up to the close of the work, and made all of the determinations by this method on the general series of waters. It was arranged that he should also make the determinations of nitrates and take charge of the evaporation at low temperature of the samples of water destined for the pathological experiments with rabbits.

At my suggestion, and on the application of the executive committee of the National Board of Health, Dr. J. T. Tanner, U. S. N., was detailed by the Secretary of the Navy for duty with the Board in connection with the research, and came to the University of Virginia in consequence. Dr. Tanner was educated at this institution, graduating here in medicine in 1875. He showed special taste for, and devoted special attention to chemistry while here as a student, and occupied himself with analytical chemistry in the working laboratory during nine months. He entered the Navy in the autumn of 1875, as assistant surgeon, and passed his examination for promotion in 1879. He was on duty at the Boston navy-yard when directed to report to the National Board of Health. He is thoughtful and well informed, very neat, quick, and accurate in manipulation, and shows much mechanical skill in the use and construction of apparatus. As he had already had, during his stay here as a student, some experience in the use of potassium permanganate, it was settled that he should take charge of Tidy's permanganate process. He was also to determine the nitrites, and any ferrous salts, sulphureted hydrogen, or other substances whose presence might lead to reduction of permanganate, and would have therefore to be determined and allowed for. And he was to expel from each specimen of water, collect, and analyze the dissolved gases. The whole of the work under these heads was performed by Dr. Tanner. He further examined the appearance, as to color, clearness, &c., of each water in a 2-foot tube.

Dr. Chas. Smart, U. S. A., who was already, under an order from the Secretary of War, engaged in scientific research for the National Board of Health, took charge of the portion of the work to be carried out at Washington. Dr. Smart had pursued a course of chemical study under Professors Clark and Brazier at the University of Aberdeen in 1858, 1859, and 1860. He entered the military service of the United States as assistant surgeon of volunteers in 1862, and has been a captain in the Medical Corps of the Regular Army since 1866. Since 1872 he has occupied himself with chemical work, mainly on points connected with hygienic matters. He has practiced Wanklyn's process extensively, having examined many western water supplies by means of it, and from 1875 to 1879 collected every snow and rain fall of note and distilled it with alkaline permanganate. In 1879 and 1880 he examined for the National Board of Health a large number of waters in Mississippi and Tennessee, New Orleans and Mobile, while the remainder of 1880 was occupied with the examination of a series of food samples. Dr. Smart is full of the spirit of unprejudiced research, careful and exact in the details of manipulation, and the albuminoid-ammonia process, for the application of which his previous experience specially fitted him, could not have been placed in better hands. He made all the determinations of "free" and "albuminoid" ammonia by this process. It was arranged with him that he should also determine the total solids left on evaporation, the effect of ignition on the residue, the chlorine, the consumption of oxygen in the Kubel process (hot, acid permanganate), and the production of any precipitates by tannin. He noticed the appearance of the water as to color, as, although the examination of this in a stratum of greater depth had been committed to Dr. Tanner, Dr. Smart's connection with the research from beginning to end was unbroken.

As regards the microscopical and biological part of the work, of which Professor Martin, of the Johns Hopkins University, had kindly taken charge, he himself divided the details of the methods to be used, and began the observations, but on its soon appearing that much more time would necessarily be consumed than he could spare from his other duties, the trustees of the university liberally authorized the appoint-

ment and payment of an assistant—Mr. W. H. Howell, a graduate scholar in the biological department—who aided in making the observations until the beginning of the summer vacation.* In anticipation of the absence from Baltimore of Professor Martin during the vacation, Dr. Geo. M. Sternberg, U. S. A., who was engaged in other researches for the National Board of Health, went thither from Washington, observed for some time the arrangements made by Professor Martin, and, on the latter going away for the summer, took up the work himself. Before very long, however, Dr. Sternberg desired to return to active medical duty, and on his own application he was relieved. An arrangement was at once entered into with Dr. Edw. M. Hartwell to take the vacant place, and no break occurred in the continuance of the work. Dr. Hartwell, who remained in charge to the end, and by whom a large proportion of the observations reported were made, is a graduate in arts (1873) of Amherst College, Massachusetts. He spent four years after leaving college in teaching, partly in the direction of natural history, devoted the greater part of the summer vacation of 1874 to study at the Anderson School of Zoology on Penikese Island, and was similarly occupied with geology in 1875 in Kentucky with Professor Shaler, of Harvard University. He afterwards began the study of medicine in Cincinnati, and for the last three years has been at the Johns Hopkins University, first as a graduate student, and later, for two years, as fellow in biology, receiving his degree of Ph.D. in June, 1881, after examination in animal physiology, comparative anatomy, and animal histology. In the same month he became, by private arrangement with Dr. Sternberg, his assistant in the work for the National Board of Health, so that on taking sole charge of the water observations he was already fully trained.

PRELIMINARY AND INCIDENTAL LABORATORY WORK.

The delay which has been alluded to in connection with the combustion process caused even more time to be spent by all three of the analysts† than it had been intended should be given to arrangement of apparatus, preparation and testing of reagents, and an extensive series of experiments (many in duplicate and triplicate) for practice, including a number made on water, containing known kinds and amounts of organic matter, prepared by me, but whose contents were unknown to the analysts until their experiments had been made, on all of which reports were made to me.

In the course of this preliminary work certain points in reference to the individual methods were examined, and the results may properly be introduced at this stage of the report. Some observations bearing on these points were made during the progress of and in immediate connection with the main investigation, but it was obvious that no collateral questions, involving any distinct departure from the general mode of procedure which had been decided upon, could be allowed to interfere with the strictly uniform application of the processes to be tested, once the study of the principal series of waters had begun. Some of the results to be now reported were obtained by work done during the more advanced stages of the investigation, but done without interference with the regular course of water analyses.

POINTS EXAMINED IN REGRARD TO THE COMBUSTION PROCESS—CHANGE OF ORGANIC MATTER IN WATER ON KEEPING.

While it was arranged that the examination of each water sample should be made at the same time by each of the processes used, and thus any uncertainty arising from possible change in the water itself on keeping was eliminated so far as the test of methods was concerned, it was manifestly impossible to secure exactly the same interval of time in each case between the drawing of the sample and its chemical examination. Every effort was made to shorten this time in all cases, but the waters coming from various distances, some samples were rather longer on the road than others. Except in a few cases there was not a difference of more than a day or two. Although, then, this question of change on keeping did not affect the comparison of methods, it might influence interpretation of results as to the sanitary relations of natural waters, and it was proposed that incidentally some attention should be given to the reanalysis of particular samples after they had been kept for a given number of days. This was done, and will be reported on, for the permanganate and albuminoid ammonia processes, but the consumption of time in the combustion process was so much greater, and the importance of having duplicate results for each water as first received was so apparent, that the re-examination by this method of samples kept over was impossible.

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* The Johns Hopkins University also provided the rabbits used in the earlier portion of the work.
† Since all had to begin the main work at the same time.

LOSS OF ORGANIC MATTER DURING EVAPORATION OF WATER.

One of the most important questions to be settled in regard to the combustion process was that of the occurrence or not of loss of organic matter during the evaporation of the water. Evidence under this head was obtained during the progress of the main work, and will be discussed in the summing up of this report; but two points from outside sources bearing on the question were noted incidentally and may be mentioned here.

In the early spring of this year (1881) the water supply of Baltimore had for a while a marked disagreeable taste, described as suggestive of putty, and professor Remsen, of the Johns Hopkins University, was requested to examine into the cause. He found that the water when hot had an odor analogous to the taste, and on treating it by the Wanklyn process he found the "free ammonia" distillate presented a more strongly disagreeable smell, which was yet further increased on the continuation of the distillation with alkaline permanganate. After obtaining the figures for "free" and "albuminoid" ammonia separately, another portion of water was treated at once with permangate and caustic potash, and an amount of ammonia was found in the distillate greater than the sum of the "free" and "albuminoid" before obtained. Furthermore, on applying the acid permanganate process, it was found that the reducing effect producible by the organic matter present was reduced by about one-third when a specimen of the water had been previously evaporated to half its original volume. The conclusion was drawn, that the water contained a nitrogenous form of organic matter capable of being voalatized along with the vapor of water.

Dr. Smart kindly sent me the notes of an experiment which he thought of making on the decomposition of urea by boiling its solution, respectively, with and without addition of sulphurous acid, it having been suggested that this substance—urea—would be particularly likely to occasion loss during the evaporation for the Frankland process of water polluted by sewage. 500 c. c. of ammonia-free water containing 10 milligrams of urea, and as much of a like solution with the addition of 20 c. c. of sulphurous acid (water saturated with SO_2), were separately distilled. The solution without sulphurous acid gave off ammonia from the first, in decreasing amount as the distillation went on, the first portion collected giving .19; the second .11; the third .09; the fourth .07. The first portion of the distillate from the solution with sulphurous acid smelled strongly of sulphur dioxide and gave no reaction for ammonia with the Nessler reagent, the second portion showed a trace of ammonia escaping, represented by .005, the third gave .03, and the fourth .10. At this stage 2 c. c. more of sulphurous acid was added, and the fifth portion of distillate collected again gave no ammonia, but in the sixth .07 was again found. So that, under the conditions stated, the sulphurous acid appears to protect urea from decomposition until itself driven off by continued heating. It is to be remembered that in the course of the usual evaporation of water to be examined by the Frankland process the water, containing a certain amount of sulphurous acid, is *progressively* fed into the evaporating dish, so that each portion introduced brings its protecting material with it, but on the other hand, in consequence of the increasing concentration of the liquid in the dish, the proportion of sulphurous acid to organic matter will be a continually diminishing one.

INFLUENCE OF TIME TAKEN FOR EVAPORATION.

Mr. Noyes was inclined to believe that he could trace some effect on the amount of organic carbon and nitrogen obtained by combustion of the evaporation having been in a few cases protracted beyond the usual time, but the number of cases was insufficient, and the range of variation in time too small, to admit of this being stated with any confidence. It is quite clear that the dish containing the residue of evaporation ought not to be allowed to remain on the water-bath after the residue has become dry.

FORMATION OF SULPHURIC ACID BY OXIDATION OF THE SULPHUROUS ACID USED.

From time to time, but particularly in the earlier part of the work, great trouble was encountered, much more than has apparently been noticed by others who have used the process, from the formation of sulphuric acid during the evaporation, sometimes producing visible charring of the residue, and this notwithstanding the use of as much sodium acid sulphite as is recommended by Frankland, or even much more, so that in some instances, aside from the manifest undesirability of having a large amount of foreign saline matter present during the evaporation, the quantity of such matter present in the residue suggested the risk of carbon being lost during the combustion by its particles getting wrapped up and sheltered from oxidation. It was to remedy this suspected evil that the practice was introduced of mixing the residue with cupric oxide for the combustion by gentle trituration in an agate mortar. The trouble from sulphuric acid was of irregular recurrence, and it was difficult in each case to know beforehand how much of the sodium acid sulphite should be added. The attempt was made to substitute barium sulphite for the acid sodium sulphite. This was found to change readily to sulphate during the evaporation. No perceptible advantage was observed to arise as to the prevention of traces of sulphuric acid being

found in the residue, although this was left in much better condition to burn, on account of its pulverulent form.

The formation of sulphuric acid did not seem to be necessarily connected with the presence of nitrates in unusual quantity in the water, but rather appeared to be due to absorption of atmospheric oxygen, and to be increased by extension of the time occupied in evaporation. In all cases in which this trouble arises the results must be considered untrustworthy; the figure for carbon is liable to be too low in consequence of destruction of organic matter, while that for nitrogen is likely to be too high on account of ammonia absorbed from the atmosphere.

DIFFICULTY AS TO DESTRUCTION OF NITRATES.

It is stated by Frankland that if sulphurous acid be used as directed by him, with the addition of a drop of ferrous chloride, any nitrates or nitrites present are completely decomposed during the evaporation of the water, so that no nitrogen from this source remains in the residue for combustion. To make sure of this result he directs the evaporation of an additional quantity of sulphurous acid upon the residue when nitrates are present in more than usual amount. The series of waters examined for the purposes of the present research included a considerable number in which nitrates were present in large quantity, and in these cases it was found that the reduction by sulphurous acid, with all the precautions recommended by Frankland, was unquestionably liable to prove incomplete; undecomposed nitrates in some instances remained in the residue. Nay, more; even when the amount of the salts present was too small to require under Frankland's rule the evaporation of additional sulphurous acid on the residue, there was occasionally ground for at least suspecting incomplete reduction during the regular evaporation. Thus, in a well water examined in duplicate on October 3, the nitrogen of nitrates was 1.06 parts per million,* the carbon determinations agreed well, everything connected with the combustion was satisfactory, but the figure for organic nitrogen (plus free ammonia — the latter = .02), which was .39 per million in the one analysis, rose to .68 in the other. The effect of incomplete reduction of nitrates has generally been looked at as vitiating the determination of organic nitrogen; but it might conceivably affect the carbon also; the nitrates of calcium and magnesium seem to be those more commonly present, but if it be admitted that alkaline nitrates might occur in the residue, there would manifestly be danger of loss of organic carbon by formation of alkaline carbonates during the combustion.

OTHER METHODS OF DEALING WITH NITRATES—USE OF BORAX.

It has been recommended by Frankland † in the case of strongly ammoniacal waters, as an accurate mode of determining organic nitrogen, to dissipate the ammonia during evaporation by adding boracic acid or borax instead of sulphurous acid, making a separate combustion for carbon with a residue obtained with the aid of sulphurous acid, as boracic acid does not completely decompose the carbonates. It was thought that borax might perhaps be made available in dealing with the nitrates, by substituting it for sulphurous acid during the evaporation, and getting as the result of the subsequent combustion the nitrogen of organic matter plus that of the nitrates and nitrites, from which sum, the nitrogen of these salts having been determined, the organic nitrogen would be obtained by subtraction. This plan was tried in several cases, but Mr. Noyes found the residue left on evaporation to cling so tenaciously to the glass dish, and to present so much difficulty in removal and mixing with cupric oxide, that he expressed himself as entirely without confidence in the result obtained on combustion.

LECHARTIER METHOD. ‡

This plan—evaporating the water alone, or with addition of a little magnesia, so as to expel all ammonia, getting from the combustion the nitrogen of organic matter plus that of nitrates and nitrites, and subtracting the two latter, was also tried in a number of cases, and with much more satisfactory results. It is open to the objection, however, that in the cases it is especially intended to meet the nitrogen of nitrates will usually far exceed that of organic matter, and hence any error attending the separate determination of the former will bear very heavily on the accuracy of the figure for the latter. Furthermore, in the presence of urea its nitrogen will be partially dissipated and lost as ammonia during the evaporation, but to a necessarily unknown extent.

M. W. WILLIAMS'S APPLICATION OF THE "COPPER-ZINC COUPLE" TO THE DESTRUCTION OF NITRATES. §

This method of dealing with the serious difficulty caused by the presence of nitrates was published at so late a date that it was not known in time to apply at in the earlier part of the main series of water analyses, and it was felt afterwards that it would not do to break in upon the uniformity of the process as it had been begun with by a change so important as the adoption of this method instead of reduction with

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* Tidy, as quoted *ante*, p. 222, only distrusts the reduction of the nitrates when their nitrogen exceeds 10 parts per million. † See *ante*, p. —. ‡ See *ante*, p. 224. § See *ante*, p. 224.

sulphurous acid. At the end of the work, however, the following special tests were made of the two in direct comparison.*

On three successive days I prepared with great care, weighing separately each time so that there should be no error due to keeping for different lengths of time, three solutions in distilled water, which may be called A, B, and C, each containing 20 mgrm. of pure tyrosine and 72.2 mgrm.† of pure potassium nitrate per liter. In order to observe any effect of the simultaneous presence of a chloride with the nitrate, C alone contained, in addition to the above, 144.4 mgrm. of pure sodium chloride. Allowing the same interval of time between the preparation of each solution and its chemical examination, Mr. Noyes, who was entirely ignorant of the nature of the liquids submitted to him, save that they contained organic matter and a nitrate,‡ applied the combustion process to two samples, each of half a liter, of each solution, treating one of these samples with sulphurous acid and ferrous chloride, in strict accordance with Frankland's instructions, and evaporating 125 c. c. of one-tenth sulphurous acid solution on the residue, while the other sample was treated by the "copper-zinc couple," as directed by Williams.§ A third sample, consisting of the particular distilled water used in making each solution, and which had been kept for the same time (forty-eight hours), was in each case evaporated in the usual way, and the residue submitted to combustion, the minute traces of carbon and nitrogen found being afterwards subtracted from the quantities of these elements found in the other analyses, so that the final figures should represent simply the results of the respective processes as applied to the weighed ingredients of the solutions.

The results obtained, expressed in parts per million, were as follows:

TABLE I.

		Frankland process.	Williams process.	Calculated.
A	Carbon	6.69	*7.14	11.93
	Nitrogen	5.24	*1.44	1.55
B	Carbon	†6.67	8.82	11.93
	Nitrogen	†7.33	1.94	1.55
C	Carbon	8.02	8.40	11.93
	Nitrogen	7.19	2.44	1.55

* The value of the results in this case was lowered by the fact that the half liter of water which was being concentrated in a retort, after the action of the "copper-zinc couple," was lost by the retort breaking. But 350 c. c. remained of the unconcentrated water which had been treated with the "couple," and this smaller quantity had to be substituted, after some delay, and the concentration and final evaporation carried out as usual.

† Traces of free sulphuric acid in the residue.

Although these experiments are few in number and not free from defects, as stated in the footnotes, they indicate pretty clearly the distinct failure of evaporation with salphurous acid to effect complete reduction of the nitrates, and a marked superiority in this respect on the part of the "copper-zinc couple." Whether the tendency to excess of nitrogen obtained even after the application of the latter method is to be ascribed to the nitrate ceasing to be acted on, even to the extent of conversion into nitrite, after its partial destruction has rendered the liquid excessively dilute, or whether it represents ammonia absorbed from the atmosphere about the dish during the final stage of the evaporation (a little sulphurous acid having been added, as directed by Williams), would require further experiments to decide. Both of the parallel sets of results give evidence of loss of carbon, and, in proportion to the total amount present, to quite a serious extent during the course of the evaporation. In reference to this, also, the Williams modification appears to some advantage in contrast with the original Frankland form of the process, but the superiority is not very great.

"BLANK" EXPERIMENTS.

A number of blank evaporations and combustions were made, as directed by Frankland, for the purpose of determining the corrections to be introduced on the score of adventitiously introduced traces of carbon and nitrogen. These experiments were made from time to time during the progress of the work (particularly after any change of reagents, such as cupric oxide), using specially purified water, sulphurous acid, ferrous chloride, and a little pure sodium chloride to form a tangible residue.

After the first early experiments made in learning the use of the apparatus, the

* Williams himself gives no quantitative results obtained by his process. He merely says that the few analyses made with its aid—all on the same class of waters, and all on waters containing very little organic matter—gave resulls agreeing closely with those obtained by the sulphurous acid method.

† This amount of nitrate represents 10 parts of N. per million of water.

‡ He was informed, also, of the amount (approximately) of the nitrate, so that he might know how much sulphurous acid to use.

§ Six square decimeters of coated zinc was used. The temperature was 25° C; the amount of water used, 1,200 c. c. After eight hours' action a trace of nitrite was found; after twenty-four hours none was detectable.

average results from all the blank combustions save one, which was vitiated by a known source of error, were—

	Mgrm.
Carbon	.089
Nitrogen	.101

or if these early blanks, made in April, be left out—

	Mgrm.
Carbon	.076
Nitrogen	.104

Frankland gives as the average allowance, in his original paper,* from four blank analyses—

	Mgrm.
Carbon	.320
Nitrogen	.045

and in his separate treatise on water analysis†—

	Mgrm.
Carbon	.060
Nitrogen	.050

POINTS EXAMINED IN REGARD TO THE PERMANGANATE PROCESS—CHANGE OF ORGANIC MATTER IN WATER ON KEEPING.

In order to obtain some little information as to the effect of keeping water for a considerable number of days, in regard to the action of its organic matter on permanganate in acid solution, it was arranged that some samples examined in the regular course of the work should be set aside, each for ten days, in glass-stoppered bottles of greenish glass, exposed to the diffuse light of a laboratory room, and should then be re-examined, using in each case Tidy's modification of the permanganate process, which will further on in this report be described in detail. In order to render the results more marked it was thought best to use samples of the artificially polluted waters. The following results were obtained:

TABLE II.

Numbers.	Character of water.	First examination.				
		Date.	Temperature of room.	Oxygen consumed.		Oxygen consumed in one hour as percentage on that in three hours.
				At end of one hour.	At end of three hours.	
		1881.	° C.	*Parts per million.*	*Parts per million.*	*Per cent.*
1	Good, ordinary spring water, with addition of an infusion of fresh herbage sufficient to form one-fifth per cent. of the whole	June 8	24	.692	.988	70
2	Same spring water, with addition of an infusion of humoid soil sufficient to form 5 per cent. of whole	July 21	27	4.898	6.522	75
3	Well water, of fair character, with addition of alkaline washings from a starch factory, sufficient to form one-fifth per cent. of whole	Sept. 14	25	1.412	1.412	100
4	Same spring water as above, with addition of washings from bag filters of a sugar refinery, sufficient to form 5 per cent. of whole	Aug. 1	28	5.172	8.252	63
5	Same spring water, with addition of washings from bone-black filters of a sugar refinery, sufficient to form one-fifth per cent. of whole	Aug. 20	26	.692	.912	76
6	Same spring water, with addition of same washings from bone-black filters of sugar refinery, sufficient to form 5 per cent. of whole	Aug. 23	27	2.6134	3.9734	66
7	Same spring water, with addition of sour drainings from tan-bark, sufficient to form 1 per cent. of whole	June 11	22	15.738	17.938	88
8	Same spring water, with addition of very weak drainings from soaking of hides at a tannery, sufficient to form one-fifth per cent of whole	Aug. 9	28	.214	.498	43
9	Same spring water, with addition of washings from scraps of skin in the manufacture of glue, sufficient to form 5 per cent. of whole	Aug. 12	29	8.828	10.592	83
10	Same spring water, with addition of water in which scurf flakes from scarlet-fever patient had been macerated, sufficient to form 1 per cent. of whole	June 21	28	1.972	2.584	74

* Jour. Chem. Soc. (Lond.), Mar., 1868, p. 93. † p. 83.

TABLE II—Continued.

Numbers.	Character of water.	Second examination. Date.	Temperature of room.	Oxygen consumed. At end of one hour.	Oxygen consumed. At end of three hours.	Oxygen consumed in one hour as percentage on that in three hours.	Oxygen consumed in one hour (second examination) as percentage on same (first examination).	Oxygen consumed in three hours (second examination) as percentage on same (first examination).
		1881.	° C.	*Parts per million.*	*Parts per million.*	*Per ct.*	*Per cent.*	*Per cent.*
1	Good, ordinary spring water, with addition of an infusion of fresh herbage sufficient to form one-fifth per cent. of the whole	June 18	28	.576	.760	76	83	77
2	Same spring water, with addition of an infusion of humoid soil sufficient to form 5 per cent. of whole	Aug. 1	28	3.875	5.579	69	79	86
3	Well water, of fair character, with addition of alkaline washings from a starch factory, sufficient to form one-fifth per cent. of whole	Sept. 24	26	.442	.722	61	31	51
4	Same spring water as above, with addition of washings from bag filters of a sugar refinery, sufficient to form 5 per cent. of whole	Aug. 11	27	4.480	5.088	88	87	62
5	Same spring water, with addition of washings from bone-black filters of a sugar refinery, sufficient to form one-fifth per cent. of whole	Aug. 30	28	.588	.960	61	85	105
6	Same spring water, with addition of same washings from bone-black filters of sugar refinery, sufficient to form 5 per cent. of whole	Sept. 2	29	2.418	3.782	64	92	95
7	Same spring water, with addition of sour drainings from tan-bark, sufficient to form 1 per cent. of whole	June 21	28	12.754	15.694	81	81	87
8	Same spring water, with addition of very weak drainings from soaking of hides at a tannery, sufficient to form one-fifth per cent. of whole	Aug. 20	26	.3054	.3054	100	143	61
9	Same spring water, with addition of washings from scraps of skin in the manufacture of glue, sufficient to form 5 per cent. of whole	Aug. 23	27	9.202	11.054	83	104	104
10	Same spring water, with addition of water in which scurf flakes from scarlet-fever patient had been macerated, sufficient to form 1 per cent. of whole	July 1	26	.696	.932	75	35	36

The greatest diminution in the amount of oxygen consumed is shown by the water polluted with infusion of scarlet-fever scurf, in which the ratio between the results for action of one hour and of three hours remains essentially unaltered. Next to this comes the water containing alkaline washings, rich in albuminoid matter, from a starch factory, showing a greater falling off for the amount used in one hour than for that in three hours.

On the contrary, the waters containing the washings from bone-black sugar filters, and that contaminated with the calcareous washings from skin scraps intended for conversion into glue, exhibit the most persistent action on the permanganate; the latter exhibits a slightly increased consumption of oxygen, with unchanged ratio between the results for one hour and three hours respectively.

ACTION OF POTASSIUM PERMANGANATE UPON SOME ORGANIC SUBSTANCES OF DEFINITE CHEMICAL COMPOSITION.

In the course of the preliminary experiments made by Dr. Tanner for practice in the process, he determined the extent to which the standard permanganate solution would oxidize a number of chemical substances. The general result was quite in accordance with that obtained in similar experiments by Frankland * and Tidy,†

* Jour. Chem. Soc. (Lond.), Mar., 1868; 83. † *Ibid.*, Jan., 1879; 78.

namely, that the oxidation is generally very imperfect, and that it varies much in extent with different substances. In regard to certain bodies, however, not included in the lists of these previous experiments, the individual results were interesting, and in some degree unexpected. This was particularly true of the lower numbers of the series of fatty acids and their salts, which, in solutions dilute enough to be comparable as to amount of organic matter with ordinary potable waters, manifested a remarkable indifference at ordinary temperatures to the action of acidified permanganate. Thus, in view of the rapid and strong reducing effect of oxalic acid, belonging though this does to a different series, it was expected that formic acid, which reduces silver salts so promptly, would behave in a somewhat similar way. But in fact solutions of formiates containing 10 mgrm. in 250 c. c. of water (the quantity operated on) consumed at common temperatures quite insignificant amounts* of oxygen. The same was true of acetates, isobutyrates, and isovalerianates; used in very dilute solutions, their action upon the standard solution of acidified permanganate within the periods of one and three hours, respectively, was either *nil* or so small as to come narrowly within the limits of accurate measurement. There was also occasionally observable a certain irregularity of action, such as Tidy has noticed in some of his experiments;† periods of activity followed by inaction, and again by renewed activity, though this point was not followed up to any considerable extent.

Sodium isolactate produced but small effect. Oxalic acid and oxalates alone underwent full and complete oxidation, even in these highly dilute solutions.

A succinate produced very trifling effect. Tartrates and citrates, which Prof. F. W. Clarke and Messrs. Beamer and Freeman‡ have lately found susceptible of pretty accurate determination by means of permanganate, presumably using the salts in moderately strong solutions, were found in solutions of a few milligrams to 250 c. c. to exhibit much of the same inertness toward the reagent, nothing approaching the theoretical amount of oxygen needed for complete oxidation being actually consumed. In one instance a rather larger quantity of citric acid produced almost no effect within the first hour, but in three hours had consumed a very considerable amount of oxygen. But little reducing action was exerted by a benzoate. Amongst amidated bodies, acetamide was inert, but much more oxygen was consumed by the more complex leucine and tyrosine. These latter substances, and others occurring among the products of putrefaction, will be noticed in the list of pure chemicals examined at the close of the work. The alkaloids examined appeared to be pretty active in reducing the permanganate.

OXIDIZING EFFECT OF PERMANGANATE WHEN USED IN ALKALINE AS CONTRASTED WITH ACID SOLUTION.

A few experiments were made under this head, the results showing for the particular substances treated a greater but less regular power of oxidation on the part of the alkaline permanganate. Thus, using in each case 250 c. c. of water, the following results were obtained in three hours with sodium formiate:

	In acid solution.	In alkali solution.
	Mgrms.	*Mgrms.*
100 mgrms. consumed of oxygen	.211	.934
50 mgrms. consumed of oxygen	.105	.407
25 mgrms. consumed of oxygen	.056	.332

TIME DURING WHICH PERMANGANATE CONTINUES SENSIBLY TO ACT UPON ORGANIC MATTER IN WATER.

In his valuable paper "on the processes for determining the organic purity of potable waters," Tidy does not say in so many words that the action of permanganate, in acid solution and at common temperature, is exhausted at the end of three hours—the longer of the two periods specified for the experiments—but this is implied in the directions for using the process and in the sentences: § "Say we have determined the

*From less than .2 to not quite 2.5 per cent. of the theoretical amount for this strength of solution, and even others several times stronger.

†Jour. Chem. Soc. (Lond.), Jan., 1879; 81.

‡Amer. Chem. Jour., June, 1881; 201.

§Jour. Chem. Soc. (Lond.), Jan., 1879; 79.

oxygen required by the oxidizable constituents of the water by a solution of potassic permanganate acting for three hours. We have further, if nitrites are present, eliminated the error they would occasion. We have now obtained a statement of the oxygen required to oxidize the organic matter (and probably that only) in the water." From one set of experiments by Tidy himself* the conclusion might be drawn that the action is not over at the end of *four* hours, but he does not notice this point. It was determined that this question should be further examined during the course of the main research now reported on, by selecting a few waters, chiefly of strongly-marked character, and continuing the action of the permanganate beyond the usual three hours until either there ceased to be any apparent effect, or at any rate proof was obtained of greatly prolonged action. Each determination at the end of a certain number of hours was accompanied by a separate blank kept for the same length of time. The results are given in the following table (III):

* *Ibid.*, 80, 81.

TABLE III.—*Absolute consumption of oxygen—parts per million.*

Nos.	Date.	Temp. of room.	Character of water.	1 hour.	3 hours.	6 hours.	12 hours.	15 hours.	16 hours.	18 hours.	21 hours.	24 hours.	48 hours.	72 hours.	75 hours.
	1881.	° C.													
1	Oct. 4	29	Water of Newport, R. I., as supplied to U. S. S. New Hampshire.	1.61	1.98	.....	.....	.....	.....	.....	3.80	3.78	(*)	.....	.....
2	Sept. 23	27	Peaty water from holes made by uprooting of trees in Great Dismal Swamp.	48.97	59.11	69.04	86.93	.....	.....	.....	.....	111.52	162.12	.....	.....
3	Sept. 24	26	Well-water of fair character, with addition of alkaline washings from wood pulp in the manufacture of paper, sufficient to form one-fifth per cent. of the whole.	5.93	7.14	8.14	.....	.....	.....	9.47	.....	.....	.....	.....	.....
4	Sept. 28	29	Same well-water, with addition of diluted blood (equal vols. of bullock's blood and pure water), sufficient to form 1 per cent. of whole.	60.49	74.31	86.07	.....	.....	.....	.....	.....	102.60	124.29	.....	.....
5	Sept. 30	29	Same well-water, with addition of same diluted blood, sufficient to form 5 per cent. of whole.	263.92	304.44	.....	.....	.....	.....	.....	.....	.....	.....	551.92	554.88
6	Sept. 21	25	Same well-water, with addition of fluid intestinal *dejecta* of typhoid fever, sufficient to form one per cent. of whole.	20.68	24.36	29.20	.....	36.92	37.02	.....	.....	.....	.....	.....	.....

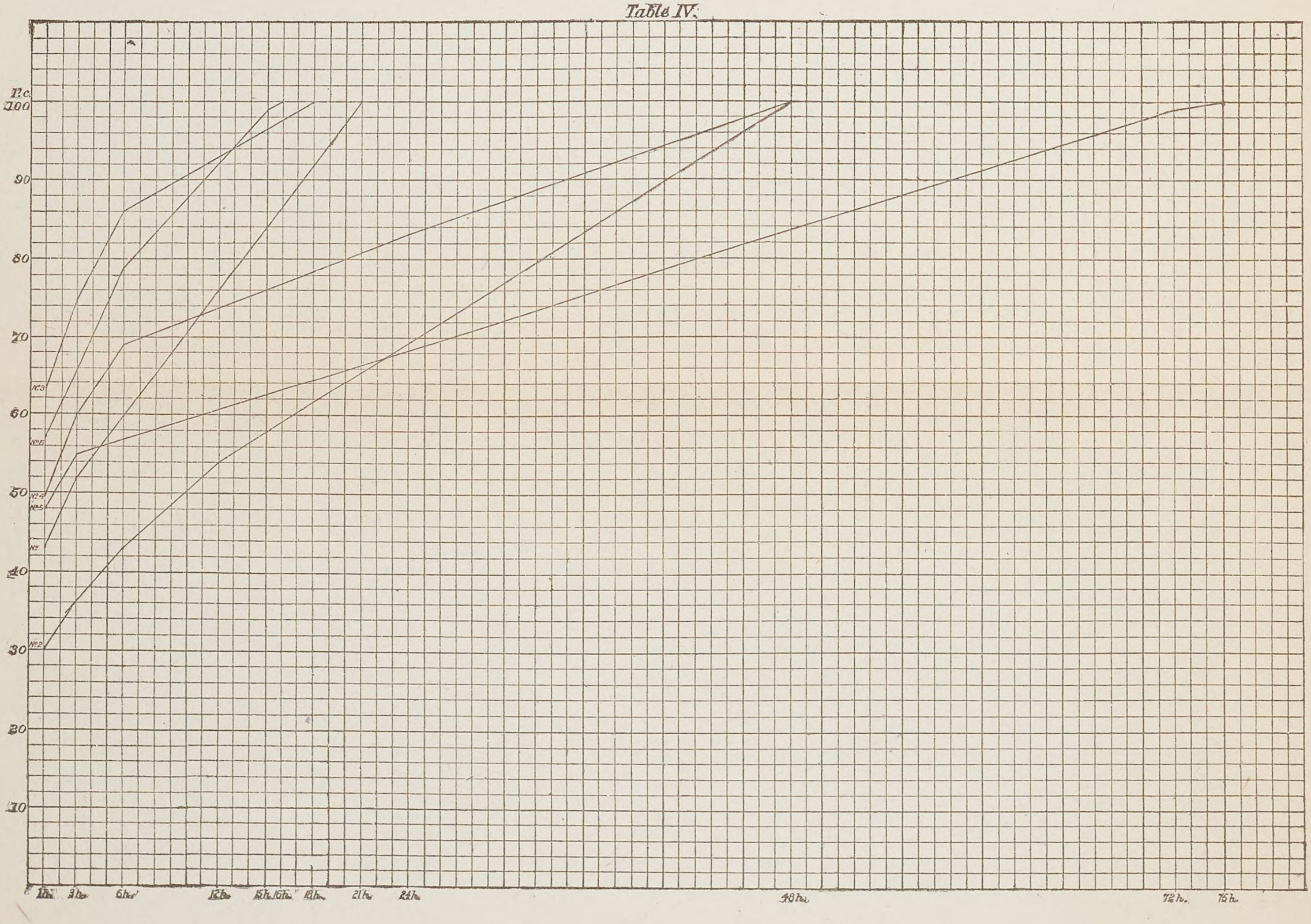
Amount of oxygen consumed at end of each period as percentage on greatest amount observed.

Nos.	Date.	Temp. of room.	Character of water.	1 hour.	3 hours.	6 hours.	12 hours.	15 hours.	16 hours.	18 hours.	21 hours.	24 hours.	48 hours.	72 hours.	75 hours.
	1881.	° C.		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	Oct. 4	29	Water of Newport, R. I., as supplied to U. S. S. New Hampshire.	43	52	.....	.....	.....	.....	.....	100	.....	.....	.....	.....
2	Sept. 23	27	Peaty water from holes made by uprooting of trees in Great Dismal Swamp.	30	36	43	54	.....	.....	.....	.....	69	†100	.....	.....
3	Sept. 24	26	Well-water of fair character, with addition of alkaline washings from wood pulp in the manufacture of paper, sufficient to form one-fifth per cent. of the whole.	63	75	86	.....	.....	.....	†100	.....	.....	.....	.....	.....
4	Sept. 28	29	Same well-water, with addition of diluted blood (equal vols. of bullock's blood and pure water), sufficient to form one per cent. of whole.	49	60	69	.....	.....	.....	.....	.....	83	†100	.....	.....
5	Sept. 30	29	Same well-water, with addition of same diluted blood, sufficient to form 5 per cent. of whole.	48	55	.....	.....	.....	.....	.....	.....	.....	.....	99	100
6	Sept. 21	25	Same well-water, with addition of fluid intestinal *dejecta* of typhoid fever, sufficient to form 1 per cent. of whole.	56	66	79	.....	99	100	.....	.....	.....	.....	.....	.....

*Same as for 24 hours. † Assumed.

S. Ex. 5——Face 243

Table IV.



It will be seen from this table that in no one of the cases examined was the action of the permanganate over at the end of three hours, that the largest proportion of oxygen consumed within this time was but 75 per cent. of the highest reading obtained, and that in this instance it was not proved that an end of the action had been reached when this highest reading was made. The average proportion of oxygen within three hours is for the six waters 57 per cent. of the highest reading; for the three waters (Nos. 1, 5, and 6), on which it may be fairly assumed the oxidizing effect of the permanganate had been exhausted, or very nearly so, the average percentage of oxygen consumed within the first three hours is just about the same, viz: 58 per cent.

Not only is it shown in reference to these samples that the amount of oxygen consumed within the first three hours does not represent the total amount capable of being taken up from permanganate by the organic matter present, but, if the results be plotted graphically, as has been done in the following table (IV), admitting that data have not been obtained for tracing the whole course of the curves, it is nevertheless apparent that these curves are unlike each other, and that a decision as to the relative oxidizability of the organic matter of the various waters would vary with the time, after the standard three hours, at which a measurement was made. Clearly this is a matter of great importance in connection with the permanganate process.

POINTS EXAMINED IN REGARD TO THE ALBUMINOID-AMMONIA PROCESS, INCLUDING WITH THIS THE DETERMINATION OF "FREE AMMONIA"—CHANGE OF ORGANIC MATTER IN WATER ON KEEPING.

The same arrangement for re-examining after an interval of a certain number of days some of the waters which had been taken up in the regular course of the work was adopted for the albuminoid ammonia as for the permanganate process, and a considerably larger number of specimens were actually thus re-examined, many of them on two, and a few on three, occasions subsequent to the primary investigation of the water. Each specimen was kept in a closed bottle of greenish glass, exposed to the diffuse light of the laboratory. The bottle was nearly filled at first, but as each sample was taken out for examination a little additional air was of course admitted, occupying the place of the water removed. Any sediment or scum was thoroughly distributed by shaking prior to each examination. That the results might be susceptible of strict comparison with those of the primary examination, a like number of measures of distillate was taken away in each instance for the free and albuminoid ammonia. The presence, appearance, or disappearance of nitrites was observed by Dr. Smart by means of the starch and potassium iodide reaction. The specimens thus re-examined were not selected on account of any peculiarity developed during the primary examination, but were taken at random as the current work of the laboratory afforded time to attend to this special point. As in the case of the permanganate determinations, the greater number of the specimens taken represent artificially polluted waters.

The following table (V) gives the results* obtained, expressed in parts per million of water:

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* The figures given in this table do not in all cases coincide exactly with those to be found in the general list of analytical results, since in this latter the constituents of the ordinary water used in preparing the various artificially polluted specimens have been subtracted from the gross figures here reported. This is needless for the purposes of Table V.

TABLE V.

[In parts per million of water.]

No.	Character of water.		First examination.		Second examination.		Third examination.		Fourth examination.		Remarks.
			Date.	Parts.	Date.	Parts.	Date.	Parts.	Date.	Parts.	
1	Water from artesian well, Charleston, S. C.	Free NH_3 Alb. NH_3	1881. June 25	.30 .04	1881. July 5	.005 .03	1881.		1881.		Decrease in both free and albuminoid ammonia.
2	Water from shallow well, Jonesville, Mich. Received from Dr. H. M. Warren; believed to have caused repeated attacks of illness of digestive apparatus; suspected of pollution from outbuildings of neighboring houses.	Free NH_3 Alb. NH_3	July 23	.22 .15	Aug. 2	.025 .185	Aug. 12	.025 .125			Decrease in free NH_3; smaller increase followed by decrease in alb. NH_3. Nitrites present at first examination; not at second or third.
3	Water from Crosswick's Creek, Bordentown, N. J. Received from Dr. H. H. Longstreet; represents water supply of Bordentown, as pumped for use.	Free NH_3 Alb. NH_3	July 27	.035 .175	Aug. 6	.035 .15	Aug. 17	.035 .165			Scarcely any change in either free or alb. NH_3.
4	Water from small stream at Bordentown, N. J. Received from Dr. H. H. Longstreet. This stream receives the discharge from city sewer, and afterwards empties into Crosswick's Creek.	Free NH_3 Alb. NH_3	July 26	(?) .835	Aug. 5	.09? .92					Free NH_3 obscured by other volatile matter. Small increase in alb. NH_3.
5	Water from the "Old Basin," a nearly stagnant canal leading to New Orleans from Lake Pontchartrain; not used for drinking purposes.	Free NH_3 Alb. NH_3	July 5	1.00 .83	July 15	.07 .68					Great decrease in free NH_3. Less decrease in alb. NH_3.
6	Good, ordinary spring water, with addition of infusion of fresh herbage (chiefly grasses), sufficient to form one-fifth per cent. of whole.	Free NH_3 Alb. NH_3	June 8	.06 .24	June 18	.105 .13	June 29	.10 .19			At first a slight increase of free NH_3 at the expense of the organic matter, with subsequent increase of alb. NH_3.
7	Same spring water, with addition of same infusion of fresh herbage, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	June 7	.075 .55	June 17	.18 .33	June 27	.13 .33			Free NH_3 at first increased, then diminished; its falling off accompanied by appearance of a trace of nitrites. Increase of free NH_3, accompanied by falling off of alb. NH_3; amount of latter afterwards maintained.

8	Same spring water, with addition of same infusion of fresh herbage, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	June 6	.15 1.99	June 16	.255 2.42	June 25	.47 2.14	July 6	3.54 1.18	Increase of free NH_3 at expense of organic matter; gain very large at fourth examination. Moderate increase of alb. NH_3 before falling off begins.
9	Same spring water, with addition of infusion of humus (from decaying log of wood), sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	June 17	.09 .20	June 27	.035 .145	.....	.....	.....	.....	Decrease in both free and alb. NH_3.
10	Same spring water, with addition of same infusion of humus, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	June 18	.11 .365	June 29	.11 .28	.....	.....	.....	.....	Free NH_3 remains unchanged. Moderate decrease in alb. NH_3.
11	Same spring water, with addition of infusion of humoid soil, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	July 19	.465 .50	July 29	.04 .43	Aug. 8	.04 .445	.....	.....	Trace of nitrites present at first examination. This and most of free NH_3 disappear, with slight decrease in alb. NH_3, after which no material change.
12	Same spring water, with addition of same infusion of humoid soil, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	July 21	2.26 1.44	Aug. 1	.13 1.14	Aug. 10	.175 1.10	Aug. 19	.09 1.045	Nitrites present to considerable extent at first examination; none subsequently. Large free NH_3 disappears in first ten days. Alb. NH_3 gradually decreases.
13	Same spring water, with addition of infusion of old. dry, Irish peat, sufficient to form one-fifth per cent. of whole.	Free NH_3 Alb. NH_3	June 2	.085 .115	June 13	.075 .115	June 23	.04 .11	July 2	.03 .125	Trace of free NH_3 escapes; alb. NH_3 remains unchanged.
14	Same spring water, with addition of sour drainings from piles of tan-bark, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	June 11	.04 .185	June 21	.04 .19	July 1	.05 .19	.....	.....	No change of any consequence.
15	Same spring water, with addition of same drainings from tan-bark, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	June 13	(?) .15	June 23	(?) .31	July 2	(?) .615	July 13	(?) .75	Free NH_3 obscured by other volatile matter. Alb. NH_3 steadily increases. This example shows failure of Wanklyn process (once applied) to indicate amount of nitrogenous matter present.
16	Same spring water, with addition of washings from the bag filters of a sugar refinery, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	Aug. 2	.04 .43	Aug. 13	.19 .305	Aug. 23	.025 .21	.....	.....	At first increase, then decrease, of free NH_3. Continued decrease of alb. NH_3.
17	Same spring water, with addition of same washings from bag filters, sugar refinery, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	Aug. 1	.12 1.48	Aug. 12	.325 1.48	Aug. 22	.485 1.39	.....	.....	Continued increase of free NH_3. Alb. NH_3 little changed.
18	Same spring water, with addition of infusion of normal human fæces, sufficient to form one-fifth per cent. of whole.	Free NH_3 Alb. NH_3	May 27	.115 .33	June 6	.105 .21	June 16	.055 .225	June 25	.055 .345	Free NH_3 diminishes and becomes stationary. Alb. NH_3 after diminishing begins to increase.

TABLE V—Continued.

No.	Character of water.		First examination.		Second examination.		Third examination.		Fourth examination.		Remarks.
			Date.	Parts.	Date.	Parts.	Date.	Parts.	Date.	Parts.	
			1881.		1881.		1881.		1881.		
19	Same spring water, with addition of same infusion of normal human fæces, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	May 30	1.49 4.90	June 9	3.38 3.78	June 18	1.44 4.50	.....	.....	Nitrites present in notable quantity at third examination. Free NH_3 first increased, then diminished (nitrites appearing). Alb. NH_3 first decreased, then increased (stability of organic matter diminishing).
20	Same spring water, with addition of mixed liquid sewage, from sewer at University of Virginia, sufficient to form one-fifth per cent. of whole.	Free NH_3 Alb. NH_3	June 23	.14 .07	July 2	.015 .05	.....	.....	.....	.....	Decrease in both free and alb. NH_3.
21	Same spring water, with addition of mixed liquid sewage, from Richmond, Va., sufficient to form one-fifth per cent. of whole.	Free NH_3 Alb. NH_3	July 29	.18 .235	Aug. 8	.085 .27	Aug. 18	.02 .14	.....	.....	Decrease of free NH_3. Slight increase, followed by decrease of alb. NH_3.
22	Same spring water, with addition of same Richmond sewage, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	July 28	.38 .35	Aug. 8	.01 .22	Aug. 17	.01 .21	.....	.....	At first there is loss of free and diminution of alb. NH_3; afterwards no material change.
23	Same spring water, with addition of same Richmond sewage, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	July 30	1.63 .57	Aug. 9	.025 .27	Aug 19	.04 .295	.....	.....	Ditto. In the interval between dates of first and second examinations *Dr. Tanner* found nitrites in his sample of this water, but they seem to have disappeared by August 9.
24	Same spring water, with addition of liquid from maceration in water for ten days of body of a dead cat, sufficient to form one-fifth per cent. of whole.	Free NH_3 Alb. NH_3	June 29	3.66 1.19	July 11	4.28 .61	July 21	.195 .36	July 30	.085 .215	Nitrites present in notable amount at third and fourth examinations (*i. e.*, after some water had been taken out of bottle, and air admitted); somewhat less at fourth than third. At first, increase of free NH_3, at expense of alb. NH_3; then rapid decrease with nitrification.
25	Same spring water, with addition of very weak drainings from soaking of hides at a tannery, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	Aug. 11	.31 .35	Aug. 20	.085 .17	.....	.....	.....	.....	Decrease in both free and alb. NH_3.

26	Same spring water, with addition of same drainings from hides, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	Aug. 10	1.01 .27	Aug. 20	.855 .18	.....	.....	.....	.....	Do.
27	Same spring water, with addition of washings from scraps of skin in the manufacture of glue, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	Aug. 15	1.675 1.42	Aug. 25	2.78 .74	.....	.....	.....	.....	Increase of free NH_3 at expense of organic matter; hence decrease of alb. NH_3.
28	Same spring water, with addition of same washings from glue manufacture, sufficient to form 5 per cent. of whole.	Free NH_3 Alb. NH_3	Aug. 12	4.98 6.98	Aug. 22	12.925 4.24	.....	.....	.....	.....	Ditto. The disproportion between gain of free and loss of alb. NH_3 no doubt represents increasing instability of organic matter.
29	Same spring water, with addition of liquid from maceration in water of scurf flakes from a scarlet-fever patient, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	June 21	5.46 1.52	July 1	9.54 .70	July 11	1.95 .40	.....	.....	Nitrites appear in notable amount at third examination. Increase of free NH_3 (at expense of organic matter) until nitrification sets in.
30	Same spring water, with addition of "black vomit" from yellow-fever patient, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	July 20	5.69 8.34	July 30	10.63 7.36	Aug. 9	11.36 6.46	Aug. 19	8.44 6.18	Continued loss of alb. NH_3. At first, increase of free NH_3; afterwards a diminution, without appearance of nitrites (possibly nitrates may have been rapidly formed; they do not seem to have been tested for).
31	Well water, of fair character, with addition of fluid intestinal *dejecta* from a typhoid-fever patient, sufficient to form 1 per cent. of whole.	Free NH_3 Alb. NH_3	Sept. 12	128.70 6.64	Sept. 27	111.59 5.50	.....	.....	.....	.....	Nitrites present in considerable quantity on second examination. Decrease of both free and alb. NH_3, with nitrification.

As will be seen further on, it is probably important to notice not only the total amounts of free and albuminoid ammonia obtained in any given case, but also the rates at which these are given off in the different stages of the distillation, as shown by the figures obtained for the successive fractions of distillate treated with the Nessler solution; hence these figures are given in full detail in Appendix A.

The following remarks, essentially those of Dr. Smart's report, written while he was still in ignorance of the history of the waters he had examined, represent the chief points suggested by Table V. The conditions under which the specimens of water were kept, in closed glass vessels, at first without air, afterwards with air in limited amount and but once or twice renewed, were not as favorable to rapid change as would have been free exposure to the atmosphere; yet a general survey of the table shows a manifest tendency to self-purification. No. 24 is a notable illustration; originally an excessively foul solution, it yields at the end of thirty days .085 parts of free ammonia and .215 parts of albuminoid ammonia per million, figures which might be obtained from many a cistern or river water. As a rule the albuminoid ammonia which can be evolved from the water decreases the longer the specimen is retained in the bottle, but there are some exceptions to this. In Nos. 4 and 15, for instance, there is a steady increase in the albuminoid figures, but in both of these cases it will be observed that volatile organic matter was present which interfered with the determination of the free ammonia by Nessler's reagent. This organic matter, apparently, did not pass readily into the condition of free ammonia through putrefactive agencies, but, on the other hand, by keeping, it seems to have become more susceptible to the action of the permanganate, and more of the organic nitrogen became evolved as albuminoid ammonia.

Again, in Nos. 6,11, 18,19, and 23 there first occurs a decrease in the albuminoid figure, corresponding probably with changes going on in the full and closed bottles, and subsequently an increase corresponding probably with changes instituted by the entrance of air into the bottles. In 18, four examinations having been made, the albuminoid ammonia in the last is greater than in the first experiment. In 19 (the same material, but in stronger solution) the quantities recorded are comparatively large, and have given credence to the reality of the change in those instances in which the quantities are minute. Lastly, in Nos. 3, 13, 14, and 17, no marked change is shown in the yield of albuminoid ammonia; in the first three cases probably because little or no change was taking place, but in the last because the decomposition was progressing equally, so that, as a part of the organic nitrogen which in the primary examination yielded albuminoid became converted into free ammonia, its place was taken by an equivalent amount of the organic nitrogen which was previously in a stable condition, insusceptible to the action of the permanganate. This is well seen in the detailed report of the experiment (Appendix A), in which the persistent albuminoid quantity indicating organic matter slowly breaking up is lowered from .07 to .05 parts per million. There appears to be little doubt that albuminoid is converted by natural processes into free ammonia, in view of the frequency with which a marked decrease in the former is accompanied by an increase in the latter. Compare, for example, the first and second examinations of Nos. 24 and 29.

But while this change is taking place the organic matter is undergoing an alteration in such a way as to render it more susceptible to the action of the oxidizing reagent, for the sum of the free and albuminoid ammonia in the last examination is always greater than in the first, unless, as in Nos. 7, 19, 24, 29, and 31, there are agencies at work which involve the destruction of free ammonia. Thus, in Nos. 8, 27, and 28, in which the free ammonia appears to increase at the expense of the organic matter, the sums of the free and albuminoid ammonia in the first examination, 2.14, 3.095, and 11.96, are increased in the last to 4.72, 3.52, and 17.165 respectively. One of the notable points shown by the table is the instability of the free ammonia. In cases in which the albuminoid figure is comparatively small, or within the limits which separate potable waters, even though foul, from absolute sewage or other strong organic solutions, the free ammonia disappears rapidly, as in Nos. 1, 2, 5, 9, 11, 13, 20, 21, 22, 23, 25, and 26, but in those cases in which the yield of albuminoid ammonia is larger the free ammonia seems to be generally increased on keeping, as in Nos. 8, 17, 19, 24, 27, 28, 29, and 30. Certain agencies are at work destroying the free ammonia, and if the transformation of organic nitrogen into ammonia takes place slowly, either from a poverty of organic matter, as in Nos. 1, 2, 5, 9, 11, 13, 20, 21, 22, 23, 25, and 26, or from stability of constitution, as in No. 12, the free ammonia may be removed more rapidly than it is produced, giving thus a decrease in its quantity. But if its development be rapid, from a surplus of putrescent organic matter, as in Nos. 8, 17, 19, 24, 27, 28, 29, and 30, the production may be in excess, thus yielding an increase, at least for some time. The ultimate tendency of the free ammonia is, however, to disappear, even although for a time its quantity may be increased, as is seen in Nos. 7, 19, 24, 29, and 30.

In Nos. 27 and 28 the decrease is not shown, probably because the experiment was not prolonged beyond ten days. In No. 17 the diminution does not appear at the end

of twenty days, and in No. 8 there is a continued increase up to the end of the thirtieth day; but it seems probable, in view of the general results, that with more time the ammonia in these instances would have ultimately suffered a decrease. The free ammonia remains unchanged in Nos. 3, 10, and 14, but in the first and last of these cases the quantity present is very minute, while in the last only one re-examination was made; had this water been retained for a second period of ten days it is not improbable that the quantity might have been found diminished, as in the case of No. 14.

In discussing the question, "What becomes of the free ammonia which thus disappears?", one important cause, probably chief cause, of the disappearance would have with difficulty been recognized had the waters examined been simply ordinary potable samples, with traces only of ammonia and nitrogenous organic matter. But, fortunately, among them were many strong organic solutions, in which the changes in progress could be more readily observed. In Nos. 7, 19, 24, 29, and 31, corresponding with the decrease in the quantity of free ammonia, nitrites make their appearance, thus explaining what has become of the nitrogen. The total of nitrified nitrogen was not determined in these cases, only that in the transition state as nitrites.

In Nos. 2, 11, and 12 nitrites were present at the primary examination, but absent at the re-examinations. Although in the cases which have been quoted the loss of ammonia was undoubtedly due to nitrification, it would perhaps be an unauthorized assumption to refer similar losses to the same cause in the many cases in which nitrites were looked for in vain at the end of each period of ten days. Yet there are some grounds for suggesting the probability of this. The quantity of nitrogen lost as ammonia was in most instances so small as to prevent its recognition after conversion into nitrate by the test used (Sprengel's), as this was applied especially in the presence of much organic matter, and the rapidity with which nitrites form and progress to the higher state of oxidation suggests that their production and disappearance may have both occurred during the period intervening between two examinations. That this is no mere hypothesis is proved by an interesting case which was brought to notice by Dr. Tanner. No. 23 was examined on three occasions, July 30, August 9 and 19, on each of which dates there were no indications of the presence of nitrites. This water, then, so far as these examinations went, showed a disappearance of free ammonia between July 30 and August 9, with no indication of the manner of its loss. Dr. Tanner, however, between these dates, on August 5 or 6, discovered the presence of nitrites in his share of this sample, and a portion of it was sent to Dr. Smart for examination by the Wanklyn method. This was received and examined on August 12. It contained, at that time, only a trace of nitrites, and in other respects the result was similar to that recorded for the third examination. In this case, therefore, the loss of ammonia was undoubtedly owing to nitrification, although the re-examination, at intervals of ten days, failed to disclose the fact.

What happened in this instance is possible in the others. The loss of free ammonia and of nitrites which may take place in water samples contained in stoppered bottles while awaiting analysis are points of much importance. The presence or absence of these substances in a water would oftentimes alter materially the opinion, based on the application of the Wanklyn process, which might be given as to its wholesomeness.

It may be said that the retained sample will generally yield a more favorable record than the fresh sample. Exposed to external atmospheric influences these changes would doubtless be more rapid. To these remarks it may be added, in view of the history of the several water samples, that in some cases organic matter of like character exhibits points of difference in the successive changes experienced on keeping, as for instance Nos. 6, 7, and 8, all representing similar vegetable matter, while on the other hand generally parallel courses of change may be run by organic matter of vegetable and animal origin, as for example in Nos. 8, 27, and 28.

PREPARATION OF DISTILLED WATER AND ALKALINE PERMANGANATE SOLUTION FREE FROM AMMONIA.

One of the objections which has been advanced against the Wanklyn process is that the reagents used always evolve of themselves a little ammonia during the distillation, and that this either forms a source of error or requires a troublesome correction to be applied. Thus, Leeds* has found fourteen times as much ammonia in distilled water (taking, doubtless, the early portions of the distillate) than in the river water used before it had been distilled; he has, however, recognized the possibility of preparing water free from ammonia, and pointed out his method of procedure. Tidy† says: "I believe it to be practically impossible to prepare an alkaline solution of potassic permanganate absolutely free from ammonia. I have myself followed with the

* Zeitschrift für. anal. Chem., 17; 276.
† Jour. Chem. Soc. (Lond.), Jan. 1879; 62.

greatest precision the details given by Mr. Wanklyn for its preparation, and have moreover tried a large number of other means that have suggested themselves, such as fusing the potash before dissolving, and such like, without avail; nor have I ever found any permanganate solution made by others that was entirely free from ammonia. Hence it has always been necessary to estimate the quantity of ammonia in the permanganate solution, and to deduct this from the total ammonia obtained in the actual experiment."

Dr. Smart used as his crude material distilled water furnished him from the laboratory of the Surgeon General's Office, United States Army. This contained a minute but readily determinable amount of ammonia. By continuous boiling, however, for some time in a long-necked flask the ammonia was driven off, and, as actually used, the water gave absolutely no perceptible color when 100 c. c. was treated with 2 c. c. of the Nessler reagent in a tube which gave a depth of 22.8 c. m. As regards the alkaline permanganate solution, this was boiled down in a retort from 1.25 liter to 1 liter in order to drive off any pre-existing ammonia or any of the so-called albuminoid ammonia formed by the reaction of the chemicals on organic matter accidentally present. The solution thus prepared gave *no* coloration with Nessler's reagent in 50 c. c. distilled off from one-half liter.

In one instance on so distilling a half liter the first measure of 50 c. c. which came over contained .02 mgrm. NH_3, and the second .008 mgrm. In this case the result is equivalent to but .0028 mgrm. of NH_3 in the 50 c. c. charge of alkaline permanganate used in a water analysis, and as this quantity is diluted with nine or ten times its bulk of water the ammonia taint derived from even such inferior permanganate as this would probably be imperceptibly minute.

As a direct test of the suitability of the reagents for their intended use, the following blank experiments were made: Half a liter of pure water which had been distilled from alkaline permanganate was put in a retort and distilled. The first measure which came over showed a faint trace of color by Nessler's test; the second remained unaltered. The usual amount of sodium carbonate solution was then poured in, and, 50 c. c. having been distilled off, gave no trace of ammonia. The full charge of 50 c. c. of alkaline permanganate was next added to the contents of the retort, and, another measure of 50 c. c. of distillate having been taken over, gave equally no visible indication of ammonia.

LOSS OF AMMONIA BY IMPERFECT CONDENSATION.

This is an important point in connection with the Wanklyn process, and one that seems hitherto to have been unnoticed or but lightly regarded. Attention was first drawn to it by the observation that a specimen of microcosmic salt, sent to Dr. Smart for examination without his knowing what it was, presented on distillation in very dilute solution a loss of about 20 per cent. of the ammonia formed by the Nessler reagent in a simple solution of the salt undistilled. In like manner, a very weak solution of ammonium chloride distilled with alkaline permanganate gave a loss of about 12 per cent., but on repeating the distillation very slowly, so as to give better opportunity for condensation, the loss was reduced to 3 per cent. These experiments were made with the condensing water, that of the Washington service pipes, at summer temperature, but the stream through the condenser was rapid enough to keep any difference of temperature between the inflow, outflow, and distillate within less than a degree centigrade.

The better to define the limits of the loss in question a series of experiments was made on known quantities of ammonium chloride in very dilute solution. A large stock of Wanklyn's standard (weaker) solution of this salt was prepared, representing .01 mgrm. NH_3 per 1 c. c.; this was compared with that in use for current analyses and found to be correct. An ammonia-free water was put into the retort in quantity exceeding what was needed for the experiment by 50 c. c., in order that this excess might be distilled over to prove the freedom of the remainder from ammonia. A little sodium carbonate was introduced along with the water. After allowing time for the contents of the retort to cool * the desired number of cubic centimeters of the standard ammonium chloride solution was added, making the total equal to one-half liter of liquid, the distillation was proceeded with, and the colorimetric comparisons were made with portions of the same stock solution which was being distilled. The greatest care was taken by Dr. Smart in making these comparisons. The variations in the percentage of loss are therefore due but in very small part to inaccuracy in Nesslerizing; they are owing mainly to the manner in which the distillation was conducted. One experiment on each quantity was performed in each of the two Liebig's condensers to be used in the proposed investigation of water samples. One of these condensers was rather smaller than the other, but the current through the larger was rather

* It had been suspected that the loss observed might be due to the tubulure of the retort being open during the introduction of the already hot liquid of the material to be distilled.

slower than through the other. The current in both, however, was so rapid that there was but a fraction of a degree between the temperatures of the water entering and leaving, even when the distillation was carried on at the rate of 50 c. c. in eight minutes. The actual temperature of the condensing water varied from 25° to 26°.5 C. In Table VI the losses from imperfect condensation during the distillations are reported—

TABLE VI.—*Summary of losses of ammonia from imperfect condensation during distillation.*

Amount of NH_3 distilled.	With first condenser.			With second condenser.		
	Recovered.	Lost.	Per cent. loss.	Recovered.	Lost.	Per cent. lost.
Mgrm.						
.05	.04	.01	20.0	.045	.005	10.0
.10	.0875	.0125	12.5	.0875	.0125	12.5
.20	.1850	.015	7.5	.1850	.015	7.5
.25	.2375	.0125	5.0	.235	.015	6.0
.30	.275	.025	8.3	.27	.03	10.0
.50	.4725	.0275	5.5	.49	.01	2.0
.75	.725	.025	3.3	.725	.025	3.3
1.00	.92	.08	8.0	.915	.085	8.5
1.50	1.39	.11	7.3	1.395	.105	7.0
2.00	1.8975	.1025	5.1	1.9025	.0975	4.9
2.50	2.4675	.0325	1.3	2.2725	.2275	9.1
3.50	3.3175	.1825	5.2	3.43	.07	2.0
5.00	4.3725	.6275	12.5	4.565	.435	8.7
5.00	4.63	.37	7.4	.....	.....	.....

and in Appendix B the details are given of the collection of the ammonia for the separate measures of distillate, these serving to indicate in some degree the greater or less rapidity of the distillation. The results recorded show losses varying from 1.3 to 20 per cent. The 20 per cent. loss must be regarded as exceptional, and dependent on the small quantity of material (.05 mgrm.) operated on. The 1.3 per cent. loss is also exceptional; it occurred when the gas pressure was low, and gave a flame which required more than half an hour to pass over a measure of 50 c. c. This corroborates what has already been shown to be the case, that, other things being equal, the loss is dependent on the rapidity of the distillation. The average loss, calculated from the whole table, is 7.4 per cent. or 7.2 if the two extreme results be omitted. The varying percentages of loss may be taken as representing the heating power of the flame used, or, inversely, the time occupied in the distillation. Although the experiments are tabulated regularly, they were not all performed in this order, nor were the two experiments on each quantity simultaneous, except in a few instances. Thus, while 1.3 per cent. loss was found by one condenser in 2.5 mgrms. NH_3, 10 per cent. loss on 0.5 mgrm. was the result of the operation being conducted with the other, the same low pressure affecting both burners. When the two experiments were conducted at the same time, with the same strength of solution, and with equal flames passing the measures over in equal times, as was the case with .20, .75, and 1.0 mgrm., the results were almost identical. In the third experiment on 5.0 mgrms. the flame was intentionally lowered. The measure of 50 c. c. distilled over in about twenty-five minutes, but the percentage of loss, though diminished, was not reduced as much as was anticipated.

In order to observe the effect of varying the amount of ammonia in the same charge of water, all other conditions being made as nearly as possible the same, the following three experiments were made:

1st. 500 c. c. water containing .5 mgrm. NH_3. Loss = 4.5 per cent.
2d. 500 c c. water containing 2.5 mgrms. NH_3. Loss = 5.8 per cent.
3d. 500 c. c. water containing 5.0 mgrms. NH_3. Loss = 10.3 per cent.

In these experiments the flame, the condenser current, and the time of distillation were made as closely as possible the same.*

ALLEGED RENEWAL OF ACTION OF ALKALINE PERMANGANATE ON KEEPING FOR A TIME.

Another objection which Tidy† has presented to the albuminoid ammonia process is that a sample of water may be distilled with the alkaline permanganate solution

*It seems not improbable that the imperfect condensation of ammonia, above examined, furnishes the explanation of the anomaly noticed by Tidy (Jour. Chem. Soc. (Lond.), Jan., 1879; 62–63), that sometimes the total amount of ammonia obtained by distillation of a water with alkaline permanganate was less than that known to be present in the permanganate solution alone.

†Jour. Chem. Soc. (Lond.), Jan., 1879; 62.

until ammonia ceases to be evolved, and if the apparatus be left for a few hours, carefully protected from the contamination of a laboratory atmosphere, on renewing the distillation a secondary yield of albuminoid ammonia will be obtained, equal to, if not greater than that obtained in the first instance, and so again and again fresh quantities of albuminoid ammonia may oe obtained until you have distilled over every drop of water in the retort. Tidy says that this fact has been noticed also by Rich* and others, and refers to it as a very serious source of error. Dr. Smart reports in reference to this, that when a specimen of water readily yielded up its nitrogen on distillation, giving gradually decreasing quantities of albuminoid ammonia until the last measure afforded a purely negative result with the Nessler reagent, if the residue in the retort were allowed to stand for forty-eight hours, cut off from the possibility of atmospheric contamination, and a measure of 50 c. c. were then distilled from it, no more ammonia could be obtained. Many such experiments were made, not only on the organic matter of natural waters, of which the nitrogen is very commonly given up with ease, but on artificial solutions of nitrogenous substances. No ammonia was recovered from the retort residue, even after standing for several days, in any one instance in which the original experiment was carried far enough to show that the evolution of ammonia had ceased. But waters frequently occur for which, under the conditions of Wanklyn's process, it is impossible to show that all the albuminoid ammonia has been eliminated. The organic matter may be acted upon so slowly by the alkaline permanganate that the experiment is at an end by the exhaustion of the water in the retort long before all the nitrogen which is susceptible of conversion into ammonia has been so converted. 500 c. c. of an Artesian well water from the Riggs House, Washington, D. C., for instance, gave in the five measures distilled .04, .02, .015, .015, and .015 mgrm. = .21 parts per million. In such a water the albuminoid ammonia is really an unknown quantity. Wanklyn's process affords no clew to the length of time during which this evolution of .015 mgrm. per measure of 50 c. c. might continue. The total can only be recorded as .21 + parts per million. It will be shown hereafter that a persisting evolution of equal or nearly equal amounts of albuminoid ammonia in successive measures of the distillate may, according to Dr. Smart's experience, perhaps be accepted as an indication of the presence of organic matter of a special kind. In the mean time it is obvious that if the retort residue from such a water as that of the Artesian well just referred to were permitted to stand for some hours and then again distilled an addition would be obtained to the .21 parts of ammonia per million. Many organic substances were found to break up so slowly under the influence of the alkaline permanganate that towards the close of the reaction a single measure of 50 c. c. might show scarcely a tinge of color by the Nessler test, but if 200 or 300 c. c. were distilled and returned to the retort the 50 c. c. which first passed over on renewal of the distillation might be charged with an appreciable quantity of ammonia. Hence, so far as the statement of Tidy and others implies that if the liquid after nearly all evolution of ammonia has ceased be permitted to stand for some time and again distilled a secondary evolution is obtained, is undoubtedly correct within limits in some cases. But it is difficult to accept, without specific quantitative evidence the further statement that this secondary yield will probably be equal to, if not greater than, that obtained in the first instance. This was never observed in Dr. Smart's experiments, nor any near approach to it obtained. On the other hand, it was frequently noticed that well on in the course of the distillation, and especially towards its close, when the flame of the lamp was lowered on account of the exhaustion of the contents of the retort, a particular measure of the distillate contained somewhat more ammonia than the measure which immediately preceded it. Thus in one distillation the fifth measure collected gave .035 mgrm. of NH_3 and the sixth measure .05 mgrm.; in another case the fifth and sixth measures gave .055 and .10, &c. This seems to depend upon the element of time, slow distillation with a lowered flame giving a larger product of ammonia than more rapid boiling. Prolonged action of the alkaline permanganate upon organic matter decomposing with difficulty and more effective condensation of the ammonia given off, as examined above, probably conspire to produce the effect observed.

RESULTS OF THE ALBUMINOID AMMONIA PROCESS AS APPLIED TO SOME ORGANIC SUBSTANCES OF DEFINITE CHEMICAL COMPOSITION.

Wanklyn and Chapman, soon after their process was first described, applied it to solutions containing known amounts of certain alkaloids and a few other nitrogenous substances, and having ascertained that the whole of the nitrogen present could not, in most cases, be obtained as so-called albuminoid ammonia, announced† the interesting result that definite fractions of the nitrogen could be so obtained, certain substances yielding one-half, others one-third, others one-fourth, while in some instances all could be evolved as ammonia by distillation with alkaline permanganate.

Later, Hoogenwerff and Van Dorp‡ made some experiments in the same direction,

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*Chem. News, June 6, 1876.
†Jour. Chem. Soc. (Lond.), May, 1868; 161.
‡Berichte d. deutsch. chem. Gesellsch. 1877; 1936—1878; 1202—and 1879; 158.

but upon a larger scale, with aniline, toluidine, quinine, &c. They obtained results, some of which seemed to confirm those of Wanklyn and Chapman, while others represented the production of less simple fractional portions of the nitrogen in the form of ammonia. Thus aniline gave up almost exactly half its nitrogen in this form, but paratoluidine only about 40 per cent.

At first, with a view to practice in the Wanklyn process, and testing the consistency of its results, but afterwards in order to develop more fully the nature of the alkaline permanganate reaction, and to clear up marked discrepancies with Wanklyn and Chapman's conclusions which presented themselves, a number of experiments were made by Dr. Smart upon nitrogenous organic substances of known composition. In selecting these substances, nearly all of which were sent him by me without his knowing anything of their nature, I aimed at extending the experiments, to some classes of nitrogenous compounds which had not previously been examined by this process.*

The following were the results obtained:

TABLE VII.—*Results of experiments by albuminoid ammonia process on nitrogenous organic substances of definite composition.*

Substance.	Formula.	Quantity operated on.	Per cent. of ammonia obtainable calculated.	Per cent. of ammonia obtained.	Per cent. of ammonia obtained, average.	Ammonia obtained as percentage on ammonia obtainable.
		mgrms.				
Potassium cyanide	KCN	3	26.1	7.2 +	7.9 +	30.3
		6		8.5 +		
Silver and potassium cyanide	$KAgC_2N_2$	10	17.1	4.1 +	.....	24.0
Potassium ferro-cyanide	$K_4FeC_6N_63H_2O$	5	24.1	None.	.....	.....
		100		None.		
Prussian blue	$Fe_7C_{18}N_{18}.18H_2O$	20	25.8	.45 +	.....	1.7
Potassium ferri-cyanide	$K_3FeC_6N_6$	100	31.	Trace.	.....	.....
Sodium nitro-prussido	$Na_2FeC_5N_6O,2H_2O$	5	34.2	9.8 +	8.9 +	26.0
		5		8.0 +		
Potassium iso-cyanate	KCNO	100	21.0	.45 +	.....	2.1
Cyanuric acid	$C_3H_3N_3O_3,2H_2O$	5	30.9	Trace.	.....	2.1
		10		Trace.		
		100		.61 +		
Pinacone*	$C_6H_{14}O_2,6H_2O$	100	None.	Trace.	.....	.....
Nitro-mannite	$C_6H_8N_6O_{18}$	10	22.6	.25	.18	.8
		100		.105		
Tri-ethylamine hydrochlorate.	$C_6H_{16}NCl$	2½	12.4	11.4	10.85	87.5
		5		10.3		
Leucine	$C_6H_{13}NO_2$	10	13.0	9.55	9.48	72.9
		10		9.1		
		10		9.8		
Oxamide	$C_2H_4N_2O_2$	5	38.4	29.1	28.77	74.9
		10		28.45		
Succinimide	$C_4H_5NO_2.H_2O$	2	14.4	12.5	12.15	84.4
		5		12.2		
		10		11.75		
Succinamide	$C_4H_8N_2O_2$	5	29.3	27.7	26.7	91.1
		10		26.3		
		10		26.1		
Urea (from urine)	CH_4N_2O	†5	56.7	12.7 +	12.58+	22.2
		‡10		12.45 +		
Urea (from ammonium cyanate.)	CH_4N_2O	§ 5	56.7	12.1 +	11.8 +	20.8
		10		11.5 +		
Thio-carbamide	CH_4N_2S	2	44.7	15.25 +	15.3 +	34.2
		5		15.0 +		
		10		15.65 +		

* Placed amongst the substances submitted to the analyst without his knowing anything of their nature, in order to test the trustworthiness of the process. The minute trace of NH_3 obtained from the relatively large quantity treated was doubtless due to surface condensation of NH_3 from the laboratory atmosphere, or some such cause.

† Carefully dried at 35° C., solution tested directly with Nessler reagent showed 1.4 p. c. of ammonia in the material.

‡ Air-dried, solution tested directly with Nessler reagent showed 2.2 p. c. of ammonia in the material.

§ Dried at 35° C.

* The quantities used were determined when possible by dissolving larger amounts and subdividing the solutions, as practiced by Wanklyn and Chapman; in the case of insoluble substances direct weighing was resorted to.

TABLE VII.—*Results of experiments by albuminoid ammonia process on nitrogenous organic substances of definite composition*—Continued.

Substance.	Formula.	Quantity operated on.	Per cent. of ammonia obtainable calculated.	Per cent. of ammonia obtained.	Per cent. of ammonia obtained, average.	Ammonia obtained as percentage on ammonia obtainable.
		mgrms.				
Alloxan	$C_4H_2N_2O_4$	10 10	24	7.75 + 7.8 +	7.78+	32.4
Parabanic acid	$C_3H_2N_2O_3$	10	29.8	4.05 +	.....	13.6
Asparagine	$C_4H_8N_2O_3, H_2O$	2 3 4	22.7	22 21 21.4	21.47	94.6
Para-nitro-toluene	$C_7H_7NO_2$	10	12.4	None.	.....	
Para-nitraniline	$C_6H_6N_2O_2$	5 10	24.6	7 6.45	6.72	27.3
Thio-carbanilide	$C_{13}H_{12}N_2S$	10	14.9	5 +	.....	33.6
Rosaniline hydrochlorate	$C_{20}H_{20}N_3Cl$	5 10 10	*15.1	2.9 + 3.1 + 4.8 +	3.6 +	23.8
Azobenzene	$C_{12}H_{10}N_2$	10	18.7	None.	.....	
Tropaeoline 00	$KC_{18}H_{14}N_3SO_3$	10 20	13	2.7 2.35	2.52	19.3
Benzamide	C_7H_7NO	10	14	11.15	.....	79.6
Indigotine	$C_{16}H_{10}N_2O_2$	10 10 10	13	6.4 5.85 6.1	6.12	47.1
Salicinet	$C_{13}H_{18}O_7$	50	None.	None.	.....	
Morphine	$C_{17}H_{19}NO_3, H_2O$	5, 10	5.6	.....	2.7	48.2
Morphine sulphate	$C_{34}H_{40}N_2O_6, SO_4, 5\,H_2O$	5	4.5	2.4	.....	53.3
Codeine	$C_{18}H_{21}NO_3, H_2O$	2 4 5 5	5.36	5 4.4 4.5 4.2	4.52	84.3
Quinine sulphate	$C_{40}H_{50}N_4O_4, SO_4, 7\,H_2O$	7 7	7.8	4.07 + 4.64 +	4.35+	55.8
Cinchonine sulphate	$C_{40}H_{50}N_4O_2, SO_4, 2\,H_2O$	2 5	‡9.1	4.5 + 5 +	4.75+	52.2
Strychnine sulphate	$C_{42}H_{46}N_4O_4, SO_4$	5 5 8 8	8.9	4.2 + 4.4 + 4 + 4.7 +	4.32+	48.5
Brucine	$C_{23}H_{26}N_2O_4, 4\,H_2O$§	2 5	7.3	4.75 5.4	5.07+	69.4
"Atropine"	$C_{17}H_{23}NO_3$‖ ?	2 5	5.9	5.25 4.7	4.97+	84.3
"Veratrine"	$C_{32}H_{52}N_2O_8$‖ ?	2 5	5.75	3.5 3.2	3.35	58.3
Piperine	$C_{17}H_{19}NO_2$	5 7½ 10	5.96	5.6 + 5.6 + 5.1 +	5.43+	91.1
Theine (from tea)	$C_8H_{19}N_4O_2, H_2O$	2 4 4 5 10	32.1	12.25 + ¶16.9 + ¶16 + 12 + 12.4 +	13.91+	43.3
Theine (from coffee)	$C_8H_1\,N_4O_2, H_2O$	2 5 5	32.1	15.5 + 13.6 + 14.3 +	14.47+	45.1
Glycocholic acid	$C_{26}H_{43}NO_6$	25	3.66	2.32 +	.....	63.4
Albumen (from blood)	(?)	5 5	**19	6.6 + ††8.2 +	7.4 +	38.9

* This would become 15.2 if the formula $C_{20}H_{17}N_3$, HCl were adopted for the salt.

† This non-nitrogenous substance was submitted to the analyst with the same object as for pinacone. (See above.)

‡ If the recently proposed formula of S. Kraup for this alkaloid $C_{19}H_{22}N_2O$ were adopted this number would become 9.04.

§ As this alkaloid when crystallized effloresces in an ordinary atmosphere the amount of water may have been less than this.

‖ These formulæ have, of course, no exact value, since it has been shown that the substances in question are mixtures of several distinct bases, but, based as these are on the older analyses, they give, no doubt, a fair approximation to the amount of nitrogen.

¶ See Appendix C for the variations in the process which gave these two results.

** Calculated for 15.7 per cent. of N.

†† See Appendix C.

The details of the collection of the ammonia by separate measures are given in Appendix C, exhibiting the progress of the action in each case reported.

In discussing these results in connection with the chemical nature of substances treated, some interesting points are observable. Thus, the simple cyanide of potassium and double silver and potassium cyanide yield very considerable portions of their nitrogen as ammonia, while the ferro- and ferri-cyanides, as Wanklyn observed for the former of the two, produce no ammonia, save that Prussian blue gives a small amount, too large—nearly 2 per cent—to be viewed as the result of accidental impurity, but small enough to show that this substance is attacked with great difficulty by the alkaline permanganate. The nitro-prusside treated is notably acted on, while very small quantities only of ammonia are obtained from the cyanate and cyanuric acid.

Nitro-mannite, an alcoholic nitrate, gives so minute an amount of ammonia that its production may not improbably be ascribed to impurity of material, though this was handsomely crystallized, and apparently pure. The true nitro-compound, nitro-toluene, gives, in accordance with Wanklyn's experiments on this class of substances, no ammonia. The same thing is true of azobenzene, but tropæoline 00, also an azo-compound, yields a considerable quantity corresponding, probably, to a part of the one-third imidic nitrogen of the di-phenylamine. The amines, so far as represented by tri-ethylamine hydrochlorate, give ammonia enough, making allowance for loss by imperfect condensations, to render probable the elimination of all their nitrogen in this form. Aniline was found by Hoogenwerff and Van Dorp to give up half its nitrogen as ammonia, while it has been noticed above, as formerly by Wanklyn, that the nitrogen of nitro-compounds is not thus evolved; in the case of nitraniline it is noticeable that about one-fourth of the total nitrogen, or one-half of that in the amidogen, is obtained. A considerable quantity of ammonia is afforded by the rosaniline salt, though far less than the equivalent of all the nitrogen; much less also, even if the highest figures be taken, than was obtained by Wanklyn. Several of the amides, as oxamide, succinamide, asparagine, and benzamide, and the imide treated, succinimide, give up so large a proportion of nitrogen as ammonia that it may probably be accepted as representing the whole, bearing in mind the loss due to imperfect condensation. Urea and thio-carbamide, the latter of which shows itself more easily attackable than the former, give much less ammonia, but still a considerable quantity. The discrepancy of this fact with the reiterated statements of Wanklyn in regard to urea will be noticed more in detail further on.

In regard to the alkaloids, some of the results look like those obtained by Wanklyn and Chapman, while others differ widely from theirs. Thus piperine gives ammonia which may be accepted as representing the whole of its nitrogen, while morphine, quinine, cinchonine, and strychnine account for about one-half; but codeine, which Wanklyn and Chapman set down as affording, like its congener, morphine, one-half, gives 84 per cent.; brucine, placed in the same list (with strychnine) as giving one-half, yields nearly 70 per cent.; and theine, stated to be "a substance which gives up one-fourth of the nitrogen as ammonia," yields on an average of many experiments nearly 45 per cent.

In reality the evidence in favor of this statement, that such simple fractions of the total nitrogen as one-half, one-third, and one-fourth are evolved as ammonia on distillation with alkaline permanganate, will be seen to rest on very slender foundations if three facts be borne in mind:

1. A variable loss of ammonia, but one which averaged more than 7 per cent. in some five and twenty experiments quoted above (in Table VI), is liable to occur from imperfect condensation in the distillation. If due allowance were made for this loss, figures which seem to nearly represent precise fractions would be considerably changed.

2. Many of the substances which have been supposed capable of affording definite fractions of their nitrogen as ammonia are in fact so gradually attacked by the alkaline permanganate, especially after the first one or two measures of distillate have been taken off, that the ending of the process as usually conducted is thoroughly indefinite; when the distillation has to be stopped on account of the concentration of the liquid in the retort ammonia is still being evolved, and in quantities which if added up for several further measures would materially change the sum total of that obtained.* In illustration of this, the experiments with the sulphates of quinine and strychnine may be referred to (Appendix C). In such cases the record made of the amount of ammonia produced will vary with the extent to which the distillation is pushed.

3. By varying the rate at which the distillation is conducted, as well as the extent to which it is carried, the total result obtained may be made to vary, as is shown in the experiments on theine (Appendix C), in which the use of a larger quantity of

* Wanklyn and Chapman give only the total amount of ammonia, not the separate portions obtained in the successive measures of distillate; they say "the distillation was continued until the evolution of ammonia ceased or became very trifling." The vagueness of the latter phrase covers the point to which attention is now directed.

water or a lower lamp flame prolonged the distillation, and raised the amount of ammonia obtained in about the ratio of 3 to 4.

EXHAUSTIVE TREATMENT WITH ALKALINE PERMANGANATE OF VARIOUS NITROGENOUS ORGANIC SUBSTANCES OF DEFINITE COMPOSITION.

In view of the indefinite termination of many of the above experiments, it became a matter of interest to ascertain how much of the nitrogen in a given case was susceptible of conversion into ammonia on prolonging much further the action of the alkaline permanganate, and it was proposed by Dr. Smart himself that he should make a series of exhaustive distillations with this object in view. Two methods were available: to replenish the liquid contents of the retort from time to time with organically pure and ammonia-free water, and so carry the evolution of ammonia from the organic substance to its completion; or to concentrate the distillate by repeated returns to the retort, and redistill until complete exhaustion of the susceptible nitrogen was obtained. The former plan entailed the consumption of a large quantity of water which had to be very specially prepared; the latter involved increased loss during the repeated condensations of the same ammonia. In carrying out the experiments a combination of these methods was adopted. So long as the evolution of ammonia was considerable the retort was replenished with pure water, but when the evolution became small the distillate was returned for concentration. Thus the thorough exhaustion of the substances with moderate quantities of water was insured, while the loss from imperfect condensation was kept within bounds. No experiment was concluded until 200 c. c., distilled and returned to the retort, gave less than .005 mgrm. of NH_3 in the first measure of 50 c. c. yielded by the redistillation. The inevitable tendency of the practical difficulties encountered was to deficiency in the resulting ammonia. Beside the imperfect condensation already examined, it was found that after some hours' boiling a fur would collect on the surface of the retort, causing irregular boiling, and necessitating a transfer of the liquid to a fresh retort, during which some little loss was no doubt incurred.

The experiments were extremely tedious and troublesome; thus, for example, one of those on urea lasted four days, that on Prussian blue five days, and that on cyanuric acid consumed the greater part of two weeks.

The following substances were thus treated, with the results recorded in connection with each:

TABLE VIII.—*Results of exhaustive experiments by albuminoid-ammonia process on nitrogenous organic substances of definite composition.*

Substance.	Formula.	Quantity operated on.	Per cent. of ammonia obtainable, calculated.	Per cent. of ammonia obtained.	Ammonia obtained as percentage on ammonia obtainable.
		Mgrms.			
Silver and potassium cyanide	$KAgC_2N_2$	5	17.1	18.24	106.1
Prussian blue	$Fe_7C_{18}N_{18}, 18H_2O$	20	25.8	7.82	30.3
Cyanuric acid	$C_3H_3N_3O_3, 2H_2O$	50	30.9	20.36	65.9
Tri-ethylamine hydrochlorate	$C_6H_{16}NCl$	5	12.4	11.50	92.8
Leucine	$C_6H_{13}NO_2$	10	13.	9.80	75.4
Oxamide	$C_2H_4N_2O_2$	10	38.4	28.75	74.9
Oxamide (second experiment)	Do	10	38.4	28.09	73.1
Succinamide	$C_4H_8N_2O_2$	10	29.3	27.70	94.5
Urea (from urine)	CH_4N_2O	5	56.7	43.10	76.0
Urea (from ammonium cyanate)	Do	5	56.7	47.40	83.6
Thio-carbamide	CH_4N_2S	10	44.7	22.40	50.1
Thio-carbamide (second experiment).	Do	10	44.7	22.60	50.6
Alloxan	$C_4H_2N_2O_4$	10	24.	21.30	88.8
Parabanic acid	$C_3H_2N_2O_3$	10	29.8	15.50	52.
Para-nitraniline	$C_6H_6N_2O_2$	10	24.6	6.35	25.8
Thio-carbanilide	$C_{13}H_{12}N_2S$	10	14.9	11.85	79.5
Benzamide	C_7H_7NO	10	14.	11.65	83.2
Creatine (specimen somewhat colored).	$C_4H_9N_3O_2, H_2O$	5	34.52	26.70	78.1
Creatine (second experiment—purer specimen—colorless crystals).	Do	5	34.2	30.40	88.9
Codeine	$C_{18}H_{21}NO_3, H_2O$	5	5.36	5.32	99.3
Strychnine sulphate	$C_{42}H_{46}N_4O_4, SO_4$	5	8.9	5.40	60.7
Theine	$C_8H_{10}N_4O_2, H_2O$	5	32.1	25.40	79.1
Glycocholic acid	$C_{26}H_{43}NO_6$	25	3.66	2.80	76.5

Examining these results, that for silver and potassium cyanide obviously involves an error, which Dr. Smart believes to have probably been clerical, as the process of distillation lasted several days for this substance, and some one of the figures after colorimetric determination may have been entered twice upon the record; there is very little doubt that this cyanide yields the whole of its nitrogen as ammonia.

The amount of ammonia from Prussian blue is seen to be greatly increased, rendering it certain that this substance is really attacked by the alkaline permanganate. The same remark applies, and to even a greater extent, to cyanuric acid. The triethylamine salt may be fairly assumed to have undergone complete decomposition, as also succinamide; neither of these gives much more ammonia than by the usual process. Several of the amidic compounds exhibit figures suggestive of Wanklyn and Chapman's simple fractions; thus the ammonia obtained from leucine and oxamide (not much increased in comparison with the results of the usual process), is, in each case, close to three-fourths of that corresponding to the total nitrogen, and the amount yielded by thio-carbamide in two separate experiments is almost exactly one-half; but if these figures were corrected for the unknown quantity of ammonia lost by imperfect condensation, the apparently simple relations might vanish; and in the case of urea it is observable that the results of two experiments differ by 7.5 per cent. It is remarkable that urea and thio-carbamide should differ so much in behavior from each other, as also alloxan and parabanic acid, all four of these giving, however, much higher results than by the ordinary Wanklyn process. Nitraniline shows no change in the result by the continued treatment. The ammonia obtained from thio-carbanilide is more than doubled by this treatment, while that from benzamide is little increased. Creatine had not been examined before, but it is pointed out by Wanklyn and Chapman as a substance which gives up one-third of its nitrogen as ammonia; whereas we find it affording by prolonged action a far larger amount—nearly nine-tenths—for the purer specimen examined. Codeine, too, which is set down by Wanklyn and Chapman among bodies yielding one-half of their nitrogen, and from which Dr. Smart got, by the ordinary process, nearly 85 per cent., now yields over 99 per cent.; it is clearly susceptible of complete decomposition. The proportion from strychnine is seen to be increased, but is still much below that representing complete decomposition; the increase, however, is sufficient to do away with the simple relation of one-half the theoretical quantity. The change in the case of theine is much more striking, the formerly obtained percentage being nearly doubled, and the one-fourth nitrogen, eliminated as ammonia, according to Wanklyn and Chapman, appears altered to four-fifths!

In fact, the results of this exhaustive treatment with alkaline permanganate in the hands of Dr. Smart led to the same conclusion as that drawn from like treatment with acid permanganate by Dr. Tanner, namely, that the production of ammonia in the one case and consumption of oxygen in the other depend largely upon the time allowed for the action, and that for some forms of organic matter within the limits far beyond those of the Wanklyn and Tidy processes as usually conducted.

The results given in Table VIII, though requiring correction for loss of uncondensed ammonia, doubtless represent the proportion of nitrogen removable as ammonia from the several substances much more nearly than the figures given by Wanklyn and Chapman, and indicate a certain degree of definiteness of action, but this action is probably far from simple; in cases like that of leucine, unless the three-fourths obtained of the theoretical ammonia, plus that uncondensed, be assumed to represent the whole of the nitrogen, it is obvious that two or more molecules of the substance must be concerned, since the molecule includes but a single atom of nitrogen; and the statement of Wanklyn and Chapman that the nitrogen of organic substances is evolved as ammonia to the extent of definite, very simple fractions of the whole amount present must be considered as unsustained by the facts.

ERROR OF THE STATEMENT HITHERTO MADE THAT UREA DOES NOT GIVE UP ITS NITROGEN AS AMMONIA BY HEATING WITH ALKALINE PERMANGANATE.

It is singular that the generally received but erroneous idea that urea—a substance of special interest as liable to characterize a particularly important contamination of drinking water—is unacted upon, so far as the evolution of ammonia is concerned, by boiling with permanganate and excess of alkali, should have originated with Wanklyn, who has done so much to introduce and improve the albuminoid ammonia method for the examination of the organic matter of water supplies.

In an earlier part of this report is to be found a condensed account of the various papers by Wanklyn and chemists associated with him in which the behavior of urea when thus treated is referred to. It was first stated that the boiling of urea with potassium permanganate and caustic potash oxidizes a large proportion of the urea, so as to convert much of its nitrogen into free nitrogen or nitrates; then, in a footnote mention was casually made of two experiments, which seem afterwards to have

been forgotten, in which urea was distilled with sodium carbonate, caustic potash, and potassium permanganate, all added together, yielding 30 and 22 per cent., respectively, of the ammonia equivalent to the total nitrogen; then, in a paper by Wanklyn and Gamgee, it was announced that on heating urea with alkaline permanganate in sealed tubes to a temperature considerably beyond 100° C., no ammonia, or but a trace, was obtained; and subsequently, in Wanklyn and Chapman's paper on the action of alkaline permanganate upon definite organic substances, and in the several editions of the separate treatise by the same authors on water analysis, it has been repeatedly affirmed, and the statement quoted by others, as fully established, that urea does not yield ammonia by treatment with alkaline permanganate.

The following quotations from Wanklyn and Chapman will suffice to illustrate the positiveness of statement on this head: "The nitrogen of urea is evolved by alkaline permanganate, either as nitrogen gas or as nitric acid," "except in the instance of nitrocompounds, urea, and ferrocyanide of potassium, we have not met with any unequivocal instance of failure of an organic nitrogenous substance to evolve ammonia on being heated to 100° C. with a strongly alkaline solution of permanganate." "On inquiring into the other peculiarities of structure which prevent alkaline permanganate evolving nitrogen of a given organic compound in the form of ammonia, our attention is arrested by the example of urea, which evolves none of its nitrogen as ammonia when so treated." "In presence of permanganate and excess of potash, urea is doubtless decomposed, but it yields no ammonia, which is a very extraordinary and noteworthy fact. The property of yielding a torrent of ammonia when heated to 150° C. with caustic alkali, and no ammonia at all when boiled with alkaline permanganate solution, is, I believe, quite characteristic of urea."

When Dr. Smart first reported a considerable percentage of albuminoid ammonia as obtained from one of the unknown substances in his hands, which my list of what I had sent him showed to be urea, a mistake of some kind was suspected, but on sending him another sample, also without explanation or any indication of its nature, essentially the same record was returned, and subsequently the full quantitative results, both of the ordinary Wanklyn process and of the exhaustive treatment applied to three specimens from different sources, as given above in Tables VII and VIII, proved unmistakably that urea is capable of evolving a very large part, if not the whole, of its nitrogen as ammonia under the action of alkaline permanganate.

PECULIAR BEHAVIOR OF UREA AS REGARDS THE RATE AT WHICH IT EVOLVES ALBUMINOID AMMONIA.

Dr. Smart has observed that if a very dilute solution of urea to which sodium carbonate has been added, or even without this addition, be distilled, the first, and often the second measure of 50 c. c. collected of the distillate will afford a proportionately large quantity of ammonia, but the third, or fourth, and subsequent measures will show smaller and pretty nearly equal amounts. If parallel experiments be made, one with urea in water alone or with sodium carbonate, the other with the same substance in solution of alkaline permanganate, a like persistent and equable evolution of ammonia after the first one or two measures will be obtained in both cases, but the absolute amount thus equally given off will be as much again in the latter case as in the former. Thus, while the persistent equable evolution of ammonia from 5 mgrms. of urea treated with sodium carbonate under the ordinary conditions of the Wanklyn process is .05 mgrm., in each measure, .10 mgrm. is obtained by the addition of the alkaline permanganate.

Dr. Smart has noticed this peculiarity of persistent equable evolution of ammonia only in the case of urea, and is much disposed to consider it so characteristic of this substance as to deserve special attention in the course of practical water analysis for sanitary purposes. He thinks that "a water which in the third or fourth measure of its distillation by the Wanklyn process gives a persistent evolution of 'free ammonia,' which is followed in the progress of the experiment by a persistence of twice that quantity of 'albuminoid ammonia,' probably contains urea," and even that upon these facts may be based an approximate estimate of the amount of urea present, "for since 1 mgrm. of urea" (in the usual charge of one-half liter of water) "gives a persistent evolution, with or without carbonate of soda, of .01 mgrm. in each measure, and .02 in each after the addition of the alkaline permanganate, a water which yields these quantities from the usual charge of 500 c. c. will contain 1 mgrm. of urea in the charge, or as many parts per million of urea as there are hundredths of a mgrm. of albuminoid ammonia persisting in each measure." He adds, however: "But the importance of the element of time in connection with this quantitative statement must always be borne in mind. It is true only when the distillation is carried on rapidly, as directed by Wanklyn, with the bottom of the retort well in the flame. This yields the 50 c. c. measure in 10 or 11 minutes. If the distillation is carried on slowly, so that 20 minutes are required to distill the measure, the persisting evolution will be doubled, and the urea if calculated therefrom will be higher than the reality."

Since the completion of his share of the work in connection with the research now reported on, Dr. Smart has kindly furnished me with a history of the first practical case in which he has been able to test this idea by applying it in the examination of a suspected drinking water. In this case the report of probable ureal contamination seems to have been sustained by a careful tracing out of possible channels of pollution, and the remedy applied by changing the system of pipes in connection with the cistern complained of seems to have manifested itself in the changed and improved caaracter of the water when reanalyzed.

This peculiarity of urea may well receive further examination, both as to its non-occurrence with any other substancer, and as to any modifying or masking effect which the presence of other substances along with urea may perhaps occasion.

In general, it would seem well that attention should always be given, in applying the albuminoid ammonia process, to the rate of evolution of ammonia in the successive measures of distillate, as well as to the total amount of ammonia obtained. Various characteristic differences of behavior may probably in this way be brought to light. Thus some earlier experiments of Dr. Smart appeared to show that nitrogenous matter of either vegetable or animal origin when in the recent or fresh condition yielded up its albuminoid ammonia at a definite rate, which in general terms might be put at 50 per cent. less in each successive measure of distillate than in that which preceded it; but when the organic matter, whether animal or vegetable, had been exposed for some time prior to its distillation to the decomposing influence of the atmosphere, the albuminoid ammonia was evolved more rapidly, that is, each successive measure contained less than 50 per cent. of the amount found in that which immediately preceded it. This was especially the case with the second as compared with the first measure. Other analogous distinctions might probably be observed by extended study of the process in this direction.

OTHER SPECIAL POINTS EXAMINED IN CONNECTION WITH THE CHEMICAL PORTION OF THE WORK — TIDY'S METHOD OF ESTIMATING THE AMOUNT OF NITRITES IN A WATER BY IMMEDIATE ACTION ON PERMANGANATE.

In his first* valuable paper on the determination of organic impurities in water, Tidy, admitting the necessity of estimating nitrites when present in order to avoid confounding their action with that of organic matter on acid permanganate, says: "If nitrites are present, the quantity may be easily enough estimated by adding to a given quantity of the acidulated water a known quantity of the permanganate solution, taking care the solution is in excess, and estimating the oxygen absorbed, after standing three minutes in the ordinary manner, within which time all nitrites will be oxidized, whilst the organic matter will remain unchanged."

Dr. Tanner made some experiments which show that this rule is not to be depended upon, at any rate, for nitrites in very dilute solution. Thus, preparing carefully a standard solution of pure potassium nitrite, from silver nitrite and potassium chloride, diluted so as to represent 1 part of N_2O_3 in 1,000,000 of the solution,† and treating this with acid potassium permanganate strictly according to Tidy's instructions, the quantity of oxygen consumed after definite intervals of time were found to be, per liter—

After three minutes, .210 mgrm.

After one hour, .315 mgrm.

After three hours, .420 to .425 mgrm.

The full amount of oxygen required for complete oxidation is .421 mgrm. Hence the action of the permanganate for the prescribed three minutes only sufficed to oxidize one-half of the nitrite known to be present, and at the end of an hour but three-fourths had undergone oxidation.

On the other hand, a specimen of natural water containing organic matter and nitrites, the latter to the same extent as above of 1 part of N_2O_3 per million, as shown by perfectly concordant results from the metaphenylene diamine and naphthylamine tests in comparison with the standard solution, consumed per liter in three minutes .500 mgrm. of oxygen from the permanganate, so that in this case the effect produced within the three minutes may be considered as due, two-fifths to the nitrites and three-fifths to the organic matter present.

It might be said that the error in defect from imperfect oxidation of the nitrites is here balanced by the oxidation of some organic matter within the same short time, so that the apparent result differs from the truth only by an excess of 25 per cent. But, looking at the figures in another way, if there were in fact no nitrites at all present, and the same amount of oxidizing effect were produced upon organic matter, the ex-

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*Jour. Chem. Soc. (Lond.), Jan., 1879; 75.

†For the sake of convenience in distinguishing the different forms in which nitrogen was found in the waters of the main series examined, it was decided that the amount of nitrites (and nitrates) should be reported as so much N in this form, but the statement of nitrite as so much N_2O_3 happens here to give simple figures, and is therefore used, as it was in the actual preparation of the solutions.

periment would by Tidy's rule, lead to a record of nitrites to the extent of about .70 of N_2O_3 per million. Moreover, it is not certain, or even at all probable, that the amount of organic matter oxidizable by permanganate within three minutes is the same in different waters.

ON NITRIFICATION IN VERY WEAK SOLUTIONS OF AMMONIA EXPOSED TO DIFFUSED LIGHT.

Different views have been expressed as to the relation of light to the development of nitrites and nitrates from ammonia or ammoniacal salts. Warrington,* Stone,† and others have been led to think that darkness is essential to nitrification, while Schloesing and Müntz,‡ and E. W. Davy,§ have found that the change in question goes on as well in the light as in the dark.

Furthermore, Schönbein, Frankland,‖ and others have attributed the production of nitrites to the reducing action of organic matter on nitrates, and Ekin has expressed the opinion¶ that nitrates in water always result from reduction. Some of the results, above reported, of the re-examinations of waters after intervals of ten days throw doubt on this last sweeping opinion.

In reference to both questions the following experiments made by Dr. Tanner possess some interest.

He prepared on August 19 a series of solutions of ammonia in definite amounts in the carefully purified distilled water used for his determinations by the permanganate process.

These solutions were set aside in bottles of common greenish glass, with glass stoppers, freely exposed to the diffused light of the laboratory, for ten days. The bottles held 2,500 c. c., and about 800 c. c. of one of the weak ammonia solutions was placed in each. On August 29, September 8, and September 18 the solutions were tested for nitrite, and the quantities present were carefully determined by the use of sulphanilic acid and naphthylamine hydrochlorate. The average temperature in the room during the time of exposure was 28° C. The following results were obtained:

Strength of solution.	Nitrite equivalent to N_2O_3 — parts per million.		
	August 29.	Septemper 8.	September 18.
100 parts of NH_3, per million	None.	None.	Same as on September 8.
50 parts of NH_3, per million	Faint trace.	Very faint trace.	
20 parts of NH_3, per million	.011	.007	
10 parts of NH_3, per million	.012	.007	
5 parts of NH_3, per million	.013	.010	
2 parts of NH_3, per million	.010	.007	
1 part of NH_3, per million	.007	.005	

Here we find nitrous acid or ammonium nitrite appearing** and afterwards diminishing in amount, with exposure to daylight, and in an ammonical solution so free from organic matter that the quantity of the latter cannot have been capable of producing reducing action to an adequate extent to account for the production observed. Doubtless, however, the exposure to air was amply sufficient to supply the organized germs of nitric ferment, assuming such present in the atmosphere of the room.††

CHANGES IN AMOUNT OF NITRITES UNDERGONE BY SPECIMENS OF WATERS ON KEEPING.

As bearing on Ekin's view, mentioned above, that nitrites are *always* produced by reduction, the following facts may be quoted from Dr. Tanner's re-examinations‡‡ of

* Chem. News, Dec. 14, 1877.
† Am. Jour. Sci., June, 1878.
‡ Comptes rendus, 85; 22.
§ Chem. News, Dec. 3, 1879.
‖ Water analysis for sanitary purposes, p. 28.
¶ Report of proceedings of British Pharmaceutical Conference for 1881, in Amer. Jour. of Pharmacy; Oct., 1881; 533.
** The apparent existence of a particular strength of ammoniacal solution most favorable to nitrification is worth notice.
†† It seems unlikely that mere absorption of nitrous acid from the air was the cause of the results given in the table.
‡‡ See *ante*, page 238.

certain water samples after standing for ten days in bottles of greenish glass in diffused light. The only cases in which nitrites were found amongst these samples were the following, denoted by the same numbers as in Table II:

	Nitrites equivalent to N_2O_3—parts per million.		
	First examination.	Second examination, after 10 days.	Third examination, 10 days more.
No. 2. Spring water, with infusion of humoid soil	5.10	.05	
No. 3. Well water, with alkaline washings from manufacture of starch	None.	.10	
No. 5. Spring water, with ½ per cent. washings from bone-black filters of sugar refinery	None.	Trace.	
No. 6. Same, 5 per cent	.03	None.	
No. 8. Spring water, with drainings from hides at a tannery	None,	.03	Trace.
No. 9. Spring water, with washings from skin scraps in manufacture of glue.	.40	None.	

Thus we find nitrites not only appearing in these water samples on keeping, but also disappearing, and these results, taken in connection with those reported just above on weak solutions of ammonia as free as possible from organic matter, and those of Dr. Smart, recorded in Table V, seem to point strongly to the production of nitrites by oxidation of organic nitrogen and their subsequent conversion into nitrates by further progress of oxidation.*

VOLUMETRIC DETERMINATION OF CHLORINE IN PRESENCE OF CERTAIN FORMS OF ORGANIC MATTER.

Although the determination of chlorine in the waters examined was incidental merely in connection with the main object of the present research, it was carefully carried out by Dr. Smart, using at first the common volumetric process of precipitation with a standard solution of silver nitrate, with potassium chromate as an indicator of the reaction being ended. Attention, however, was soon attracted to a recent paper by Salkowski,† in which he states that the results thus obtained are not correct in the case of urine, and recommends as a process of much superior accuracy and sharpness Volhard's method of using ammonium thiocyanate. A measured quantity of the urine is to be diluted, usually about five or six fold, acidified with nitric acid, precipitated with a known amount of standard solution of silver nitrate, enough to leave an excess in the liquid, which is to be well shaken, further diluted to a definite volume, and filtered through a dry filter. To a measured portion of the clear filtered is added a little of a cold saturated solution of ammonio-ferric sulphate, and finally a standard solution of ammonium thiocyanate is dropped in from a burette until the red color of ferric thiocyanate makes its appearance. The quantity of ammonium thiocyanate used (calculated on the whole quantity of liquid) gives the amount of the excess of silver in the liquid, and this by subtraction from the whole amount of silver used gives that corresponding to the chlorine of the chlorides present. Dr. Smart examined the two methods in comparison with each other, and with the results of careful gravimetric analysis. For the last, cautious but thorough charring with a low flame was employed, with enough sodium carbonate to prevent any escape of chlorine, the residue being thoroughly washed, and chloride of silver thrown down from the acidified solution, and weighed, with all proper precautions. Duplicate and closely agreeing determinations were thus made of the chlorine in a specimen of dark colored, faintly acid urine; this was then diluted to different extents,

* As the nitrates were not also determined in those specimens at different periods, it is of course *possible* that at first dissolved oxygen may have produced the higher degree of oxidation on a part of the organic nitrogen, that the nitrates so formed may, as such oxygen was used up, have been reduced by surplus organic matter to nitrites, and that these, finally, may have returned to the condition of nitrates as more oxygen was taken up from the air.

† Med. Centralbl. 19; 177. Chem. Centralbl. 30 März, 1881; 203.

and the various dilutions were examined by the ordinary (chromate) and by the Salkowski (thiocyanate) process, with the following results:

	Milligrams of chlorine.		
	Chromate.	Thiocynate.	Gravimetric.
20 c. c. of a 1. per cent. dilution gave	1.45	•1.42	1.30
20 c. c. of a 2.5 per cent. dilution gave	3.70	3.60	3.24
20 c. c. of a 5 per cent. dilution gave	7.40	7.08	6.48
20 c. c. of a 7.5 per cent. dilution gave	11.30	10.54	9.72
20 c. c. of a 10 per cent. dilution gave	14.90	13.95	12.96
20 c. c. of a 25 per cent. dilution gave	38.50	34.44	32.40
20 c. c. of a 50 per cent. dilution gave	77.80	67.74	64.80
20 c. c. of a 100 per cent. solution gave	157.00	136.34	129.60

It will be seen that up to a 5 per cent. strength the results of the two volumetric methods agree pretty well, but are too high as compared with the gravimetric figures. Above this point the results by the chromate method increase rapidly, and get further from the truth, while those by the thiocyanate process exhibit on the whole a decreasing proportion of error, and remain much nearer the truth, though all somewhat too high. In the presence of some other forms of organic matter tried, as sugar, urea, leucine and theine, the two volumetric processes gave accurate results.

With regard to the sharpness of definition attainable by the two methods, Dr. Smart remarks that the iron thiocyanate is undoubtedly the better indicator. The chromate in urine dilutions assumes a citron color as the silver is added, but the appearance of the red tint can be distinctly made out unless the proportion of urine is high, say 30 per cent., when the conclusion of the experiment becomes somewhat vague. Similarly with strong solutions the thiocyanate method loses in sharpness, from a slight tinge in the acid filtrate, which obscures the first appearance of the iron color. By running in a few cubic centimeters more of silver solution, however, and approaching the terminal point a second time, accuracy can be insured. Although not perfect, Salkowski's method, as a volumetric process, appears decidedly preferable for the determination of chlorine in sewage and water polluted therewith.

CHANGES AS REGARDS DISSOLVED GASES UNDERGONE BY WATER SAMPLES ON KEEPING.

In connection with Dr. Tanner's re-examinations by the permanganate process of certain specimens of water kept over for ten days the dissolved gases were also redetermined, and with the results recorded in Table IX. All the gaseous volumes are reduced to 0° C. and 760^{mm} pressure.

TABLE IX.

FIRST EXAMINATION.

No.	Character of water.	Date.	Temperature of room.	Dissolved gases—per liter. Constituents.	By volume.	By weight.	Oxygen as percentage on sum of oxygen and nitrogen.
		1881.	°C.		*c. c.*	*Mgrms.*	*Per ct.*
1	Good ordinary spring water, with addition of an infusion of fresh herbage sufficient to form $\frac{1}{5}$ per cent. of the whole.	June 8	24	Carbon dioxide	1. 61	3. 17	
				Oxygen	4. 24	6. 06	26. 14
				Nitrogen	11. 94	14. 99	
					17. 79	24. 22	
2	Same spring water, with addition of an infusion of humoid soil sufficient to form 5 per cent. of whole.	July 21	27	Carbon dioxide	4. 67	9. 20	
				Oxygen	2. 89	4. 13	20. 33
				Nitrogen	11. 32	14. 22	
					18. 88	27. 55	
3	Well water, of fair character, with addition of alkaline washings from manufacture of starch, sufficient to form $\frac{1}{5}$ per cent. of whole.	Sept. 14	25	Carbon dioxide	8. 31	16. 38	
				Oxygen	1. 18	1. 69	8. 98
				Nitrogen	11. 96	15. 02	
					22. 45	33. 09	
4	Same spring water as above, with addition of washings from bag filters of a sugar refinery sufficient to form 5 per cent. of whole.	Aug. 1	28	Carbon dioxide	5. 76	11. 35	
				Oxygen	1. 27	1. 87	9. 88
				Nitrogen	11. 56	14. 52	
					18. 59	27. 74	
5	Same spring water, with addition of washings from bone-black filters of a sugar refinery sufficient to form $\frac{1}{5}$ per cent. of whole.	" 20	26	Carbon dioxide	1. 81	3. 57	
				Oxygen	3. 30	4. 72	22. 01
				Nitrogen	11. 69	14. 68	
					16. 80	22. 97	
6	Same spring water, with addition of same washings from bone-black filters of sugar refinery sufficient to form 5 per cent. of whole.	" 23	27	Carbon dioxide	1. 94	3. 82	
				Oxygen	2. 69	3. 85	19. 18
				Nitrogen	11. 33	14. 23	
					15. 96	21. 90	
7	Same spring water, with addition of sour drainings from tanbark sufficient to form 1 per cent. of whole.	June 11	22	Carbon dioxide	2. 61	5. 14	
				Oxygen	3. 27	4. 68	21. 40
				Nitrogen	12. 01	15. 08	
					17. 89	24. 90	
8	Same spring water, with addition of very weak drainings from soaking of hides at a tannery sufficient to form $\frac{1}{5}$ per cent. of whole.	Aug. 9	28	Carbon dioxide	0. 84	1. 66	
				Oxygen	4. 32	6. 18	28. 49
				Nitrogen	10. 84	13. 62	
					16. 00	21. 46	
9	Same spring water, with addition of washings from scraps of skin in the manufacture of glue sufficient to form 5 per cent. of whole.	" 12	29	Carbon dioxide	0. 82	1. 62	
				Oxygen	0. 53	0. 67	4. 41
				Nitrogen	11. 49	14. 53	
					12. 84	16. 82	
10	Same spring water, with addition of water in which scurf flakes from scarlet-fever patient had been macerated, sufficient to form 1 per cent. of whole.	June 21	28	Carbon dioxide	6. 61	13. 03	
				Oxygen	0. 49	0. 70	4. 02
				Nitrogen	11. 70	14. 69	
					18. 80	28. 42	

TABLE IX.—Continued.

SECOND EXAMINATION.

No.	Character of water.	Date.	Temperature of room.	Dissolved gases—per liter.			Oxygen as percentage on sum of oxygen and nitrogen.
				Constituents.	By volume.	By weight.	
		1881.	°C.		*c. c.*	*Mgrms.*	*Per ct.*
1	Good ordinary spring water, with addition of an infusion of fresh herbage sufficient to form $\frac{1}{5}$ per cent. of the whole.	June 18	28	Carbon dioxide .	3.04	5.99	
				Oxygen.....	3.87	5.53	27.94
				Nitrogen	9.98	12.53	
					16.89	24.05	
2	Same spring water, with addition of an infusion of humoid soil sufficient to form 5 per cent. of whole.	Aug. 1	28	Carbon dioxide .	8.44	16.64	
				Oxygen.....	1.74	2.49	12.52
				Nitrogen	12.15	15.26	
					22.33	34.39	
3	Well water, of fair character, with addition of alkaline washings from manufacture of starch sufficient to form $\frac{1}{5}$ per cent. of whole.	Sept. 24	26	Carbon dioxide .	2.54	5.01	
				Oxygen.....	4.21	6.02	27.53
				Nitrogen	11.08	13.92	
					17.83	24.95	
4	Same spring water as above, with addition of washings from bag filters of a sugar refinery sufficient to form 5 per cent. of whole.	Aug. 11	27	Carbon dioxide .	8.69	17.13	
				Oxygen.....	0.57	0.82	5.22
				Nitrogen	10.35	13.00	
					19.61	20.95	
5	Same spring water, with addition of washings from bone-black filters of a sugar refinery sufficient to form $\frac{1}{5}$ per cent. of whole.	" 30	28	Carbon dioxide .	3.44	6.78	
				Oxygen.....	4.98	7.12	32.06
				Nitrogen	10.55	13.25	
					18.97	27.15	
6	Same spring water, with addition of same washings from bone-black filters of a sugar refinery sufficient to form 5 per cent. of whole.	Sept. 2	29	Carbon dioxide .	5.95	11.73	
				Oxygen.....	3.49	4.99	26.06
				Nitrogen	9.90	12.43	
					19.34	29.15	
7	Same spring water, with addition of sour drainings from tanbark sufficient to form 1 per cent. of whole.	June 21	28	Carbon dioxide .	3.69	7.27	
				Oxygen.....	2.40	3.43	18.08
				Nitrogen	10.40	13.06	
					16.49	23.76	
8	Same spring water, with addition of very weak drainings from soaking of hides at a tannery sufficient to form $\frac{1}{5}$ per cent. of whole.	Aug. 20	26	Carbon dioxide .	1.82	3.59	
				Oxygen.....	5.00	7.15	32.01
				Nitrogen	10.62	13.34	
					17.44	24.08	
9	Same spring water, with addition of washings from scraps of skin in the manufacture of glue sufficient to form 5 per cent. of whole.	" 23	27	Carbon dioxide .	1.44	2.84	
				Oxygen.....	0.16	0.22	1.34
				Nitrogen	11.76	14.77	
					13.36	17.83	
10	Same spring water, with addition of water in which scurf flakes from scarlet-fever patient had been macerated, sufficient to form 1 per cent. of whole.	July 1	26	Carbon dioxide .	3.47	6.84	
				Oxygen.....	4.44	6.33	24.01
				Nitrogen	14.05	18.65	
					21.96	31.82	

On comparing these results with those as to the action of the same waters on acid permanganate, as given in Table II, we observe generally that for those samples which, judged by the effect on this reagent contained but little organic matter, the

amonnt of free oxygen in solution in proportion to nitrogen is high, as, for instance, in Nos. 1, 5, 8, and in a less degree 3, while those samples active to the largest extent upon the permanganate, as 2, 4, 7, and 9, give a low ratio of dissolved oxygen to nitrogen.

In 3 and 10, the organic matter present being of rapidly alterable character, there is a marked falling off at the end of ten days in the consumption of oxygen from the permanganate, attended by disappearance of carbon dioxide and absorption of fresh atmospheric oxygen.

On the contrary, in 2 and 7 we probably have present slowly oxidizable material, and we find that, although the consumption of oxygen from permanganate is less on the second examination than the first, there is a continued reduction in the amount of gaseons oxygen in solution. In 8 and 9 the organic matter was doubtless of much the same character, but in 8 the quantity is small, so that by the time of the second examination the oxidation is to a large extent over, and the percentage of dissolved oxygen is found increased, while in 9, with a larger amount of organic matter, the action is still going on, and the proportion of dissolved oxygen is diminshed. The evidence is very manifest throughout the table, on the one hand, of the escape into the atmosphere of surplus carbon dioxide, and on the other of the absorption of deficient oxygen, and as the extent to which these two physical changes take place will depend upon various conditions—temperature, atmospheric pressure, extent of free surface exposed by the water, amount of agitation or repose, &c.—we have here no doubt the explanation of the discordant results which Weyl and Zeitler* and others have obtained in the attempt to trace a relation between the amount of free oxygen found dissolved in a water and the extent of its action on permanganate. Thus in No. 6, with probably a considerable quantity of slowly alterable organic matter, the absorption of oxygen from the atmosphere more than keeps pace with the production and elimination of carbon dioxide, so that the amount of both gases is found increased at the end of the ten days. It is to be remembered that the temperatures observed in the room at the times at which the waters were examined by no means indicate the changes of temperature to which they had been exposed during the period of ten days.†

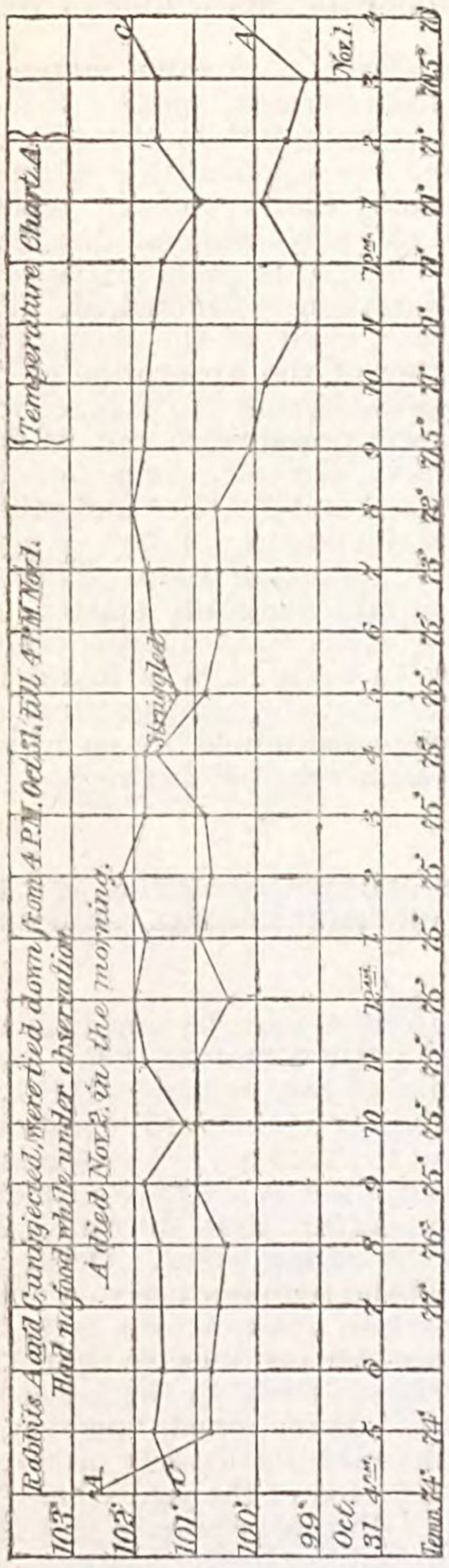
SPECIAL POINTS EXAMINED IN CONNECTION WITH THE BIOLOGICAL PORTION OF THE WORK—SPECIAL SERIES OF HOURLY OBSERVATIONS ON THE NORMAL TEMPERATURE OF THE RABBIT.

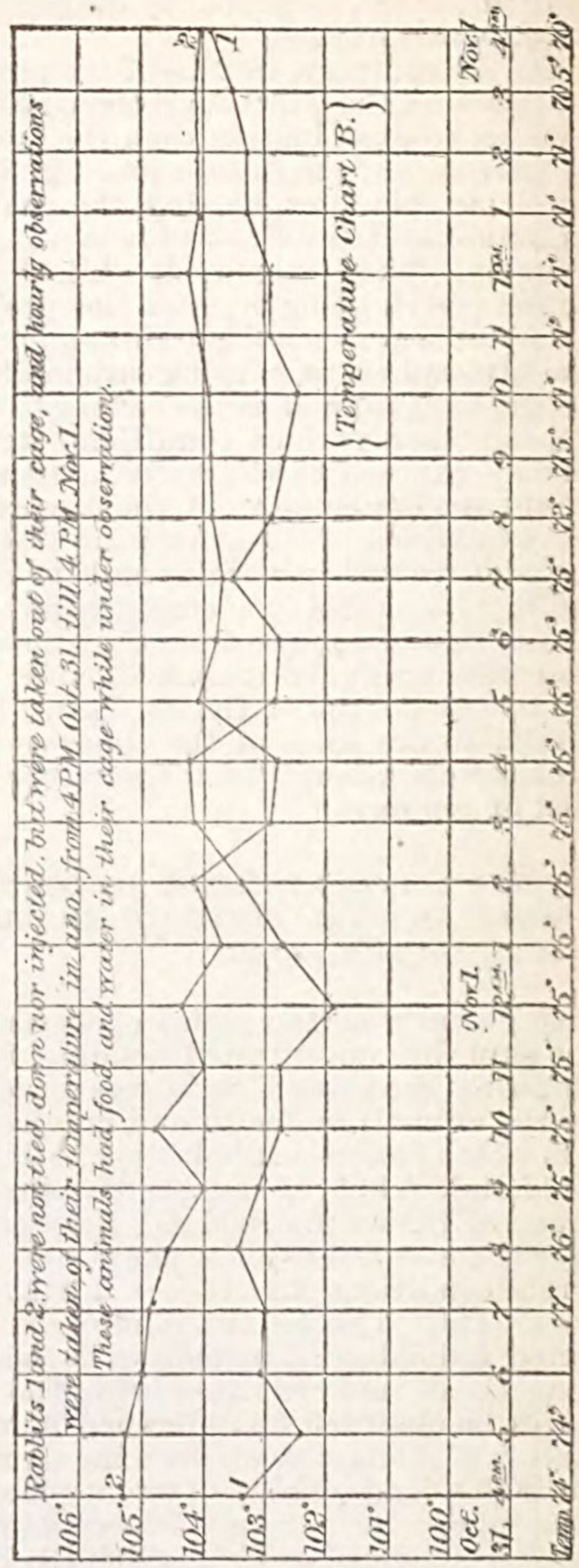
Quite early in the series of experiments made upon rabbits by injecting beneath the skin the concentrated residues from evaporating the various waters at low temperature, Professor Martin was struck with the variability of temperature exhibited by the animals in health and uninjected. The same sensibility of the vaso-motor system which causes a rabbit's ear to flush up and become hot to the touch, when the animal is taken hold of or otherwise startled, seemed to be exhibited by the mucous membrane of the rectum, and only after some time did the temperature first shown by the thermometer fall to what might now fairly be considered the normal point. Other external conditions than causes of fright seemed also to affect the temperature to a notable extent. This led to the adoption of a system of comparison observations on uninjected animals side by side with those injected with the water residues, so that, the general external condition being the same for both, the effect, if any, of the injection might be observed by difference of result in the two cases. It remained, however, a matter of interest to observe the normal temperature of the rabbit at hourly intervals through a complete day of twenty-four hours, and this at a period of the year when the atmospheric temperature was moderate and fairly steady. Professor Martin and Mr. Howell arranged to share with Dr. Hartwell the labor of making these observations, which extended from 4 p. m. of October 31 to 4 p. m. of November 1, 1881. In order to test the effect due to the animal being tied down, as in the main series of experiments with the various waters, two of the rabbits in these twenty-four hour observations were so treated, while two others were not thus confined, but were taken hourly from their cage, and replaced after the temperature had been taken *in ano*. The animals tied down were not fed or watered while under observation, while the others had food and water in their cage. One of the two not tied down had been used for several of the injection experiments, but had not been so treated since October 6, was apparently in good health, and remained so for many days after the date of the observations now recorded. The other rabbits had not previously been used. One (A) of the two tied down died on the morning of November 2. On *post mortem* examination its heart was found to contain fluid blood; its lungs were uncongested; its intestines were somewhat collapsed; and its subcutaneous veins were somewhat congested. The results of these observations are given in temperature charts A and B. It will

* Biedermann, Centralblatt, 1881; 363.

† Compare these results with those of Hatton, obtained under different circumstances.—Jour. Chem. Soc. Lond.)), May, 1881; 258.

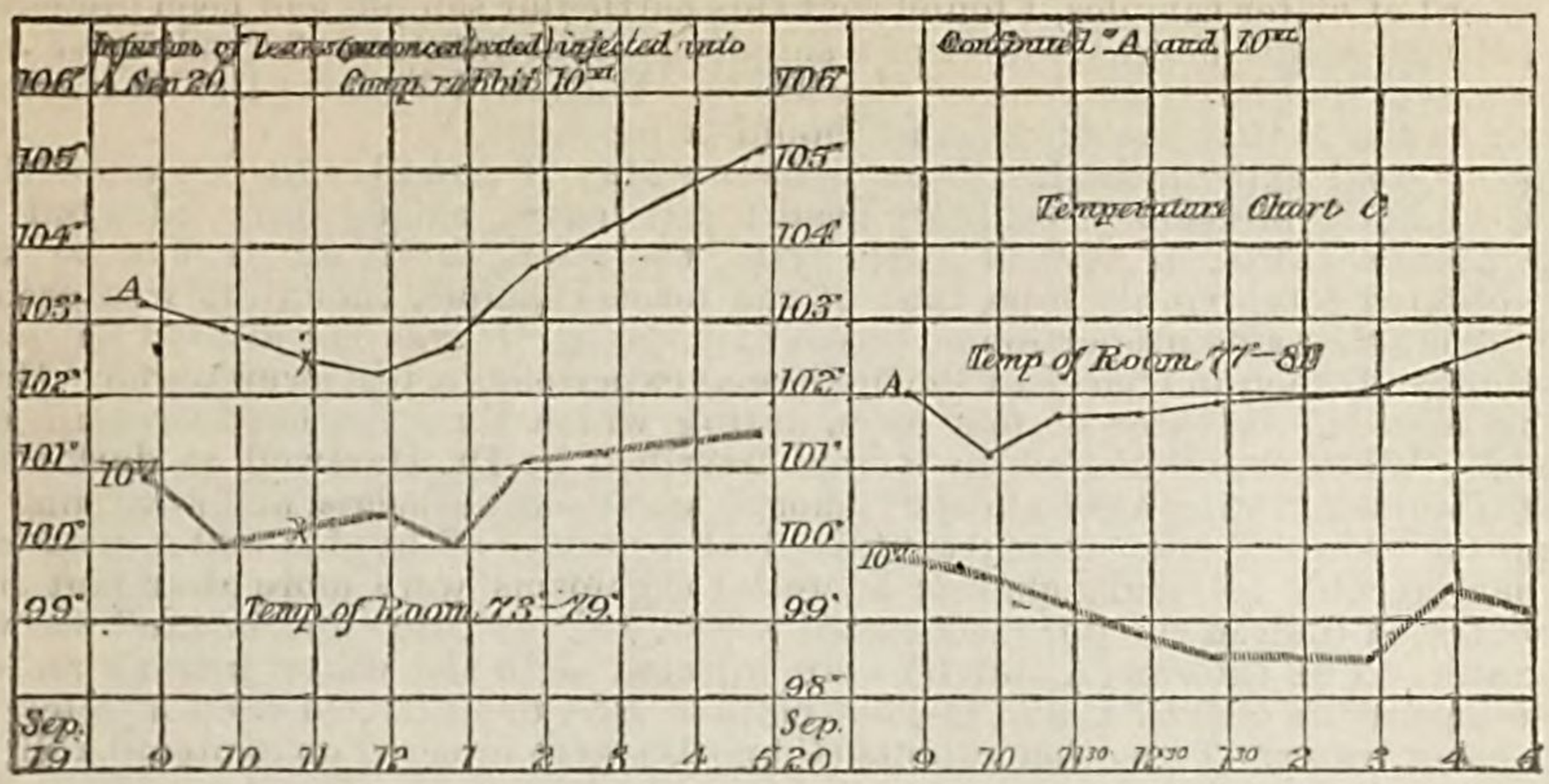
be seen in general that the absolute temperatures are lower, and the variations less frequent, irregular, and strongly marked, for the animals which were tied down than for those that were free, thus justifying Professor Martin's decision as to the arrangement for the main series of injection observations. On the other hand, the gradual lowering of temperature toward the end of the twenty-four hours, followed by an upward febrile tendency, both most marked in the case of the rabbit A, which died next day, seem to point to the exhaustive effect of the deprivation of food and water, and deserve to be borne in mind in connection with similar phenomena when observed in the course of the injection experiments.

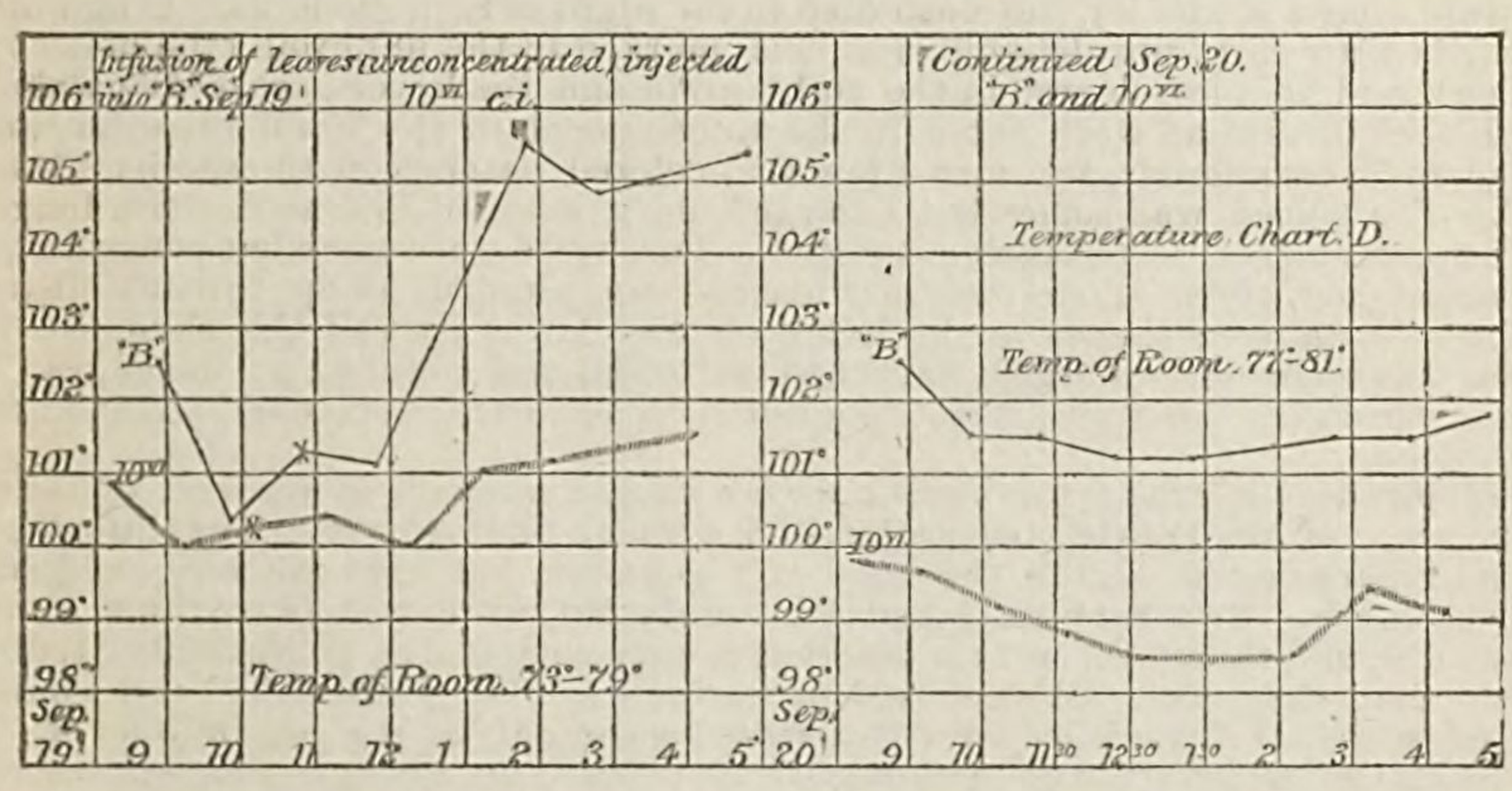

Temperature Chart A.
Rabbits A and C injected, were tied down from 4 P.M. Oct. 31, till 4 P.M. Nov. 1. Had no food while under observation
A died Nov. 2, in the morning.
Sterilized
Temperatures
Nov. 1
Oct. 31
Mean

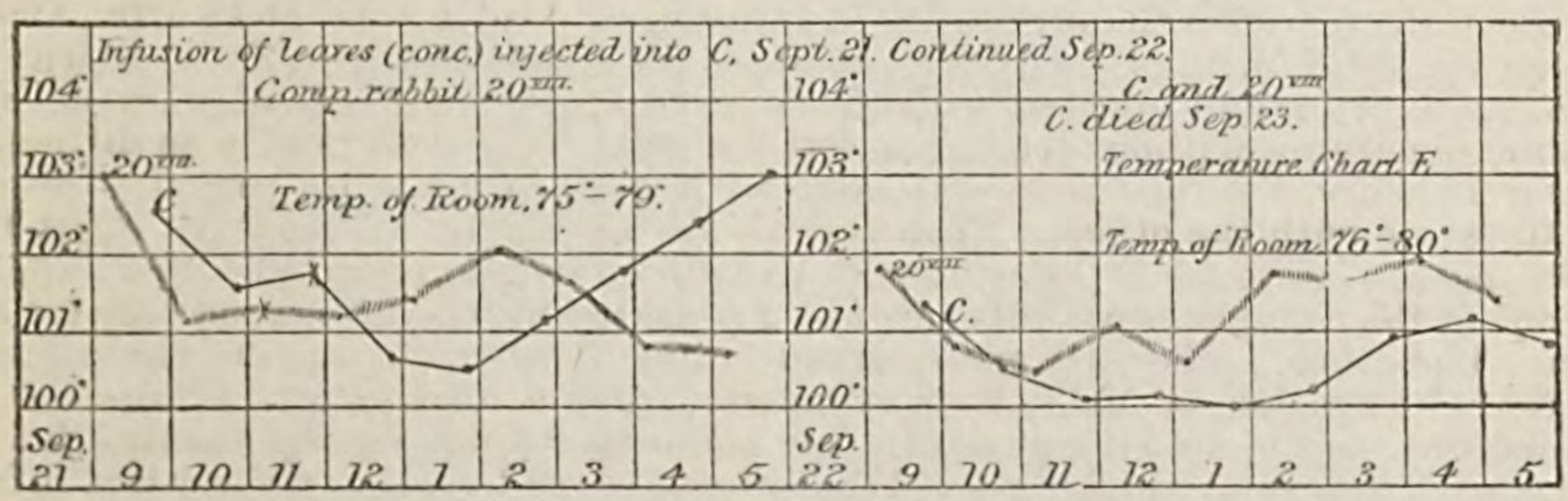

Temperature Chart B.
Rabbits 1 and 2, were not tied down nor injected, but were taken out of their cage, and hours of their temperature in the usual cage while under observation.
These animals had food and water in the
Temperatures
Nov. 1
Dec. 31
Mean

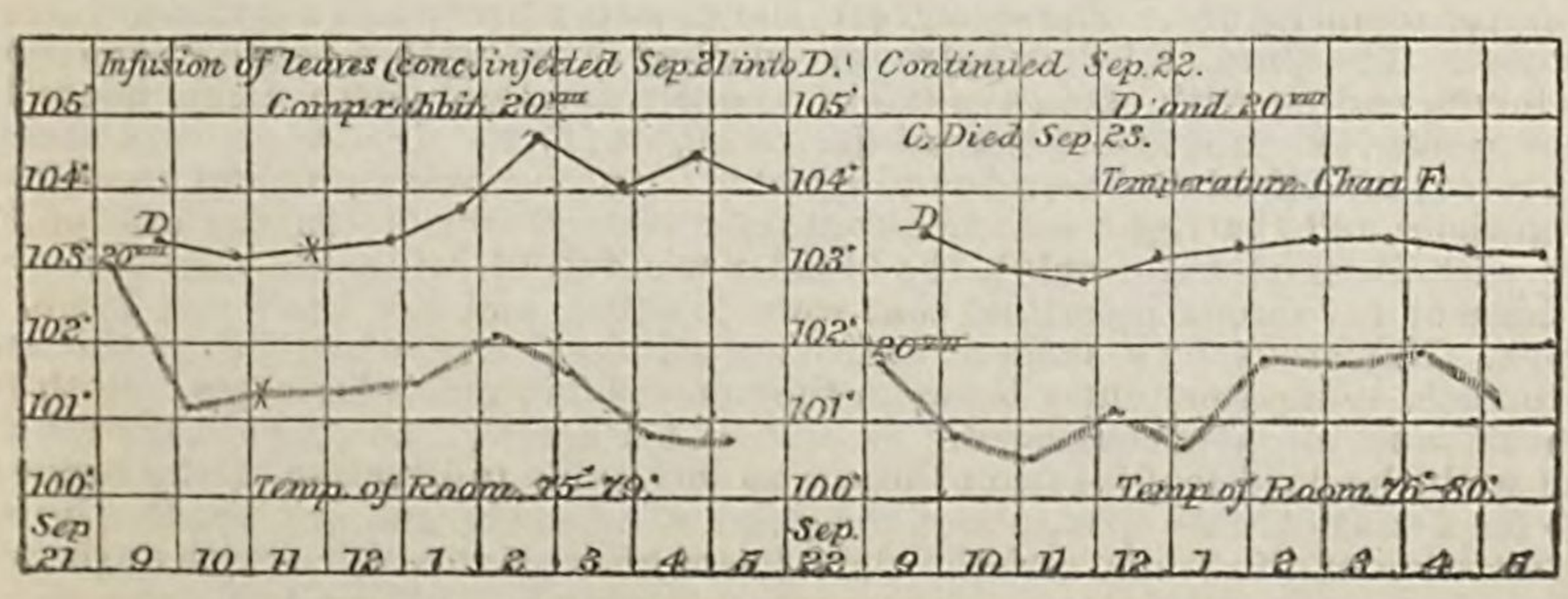
EFFECT OF SUBCUTANEOUS INJECTION OF WATER CONTAINING VEGETABLE ORGANIC MATTER.

Many passages in the writings of those who have given special attention to the sanitary relations of organic matter in water express or imply a general belief that contamination by matter of vegetable origin is much less injurious than that by matter from animal sources. Hence a case which occurred in the early part of the present research seemed to deserve special attention. A specimen of water sent to Baltimore, with, as usual, but an arbitrary number attached, gave an evaporation residue which on being injected subcutaneously produced strongly-marked fever in the case of both rabbits experimented on; death following in the case of one of them after three or four days. On receiving from Dr. Martin the report of these results and examining


Infusion of leaves unconcentrated injected into Comp. rabbit 10VI.
A Sep 20.
Continued A and 10VI.
Temperature Chart C
Temp of Room 77°-80°
Temp of Room 73°-79°.
Sep. 19
Sep. 20


Infusion of leaves unconcentrated injected into "B" Sep 19 10VI c.i.
Continued Sep. 20. "B" and 10VI.
Temperature Chart D.
Temp. of Room. 77°-81°.
Temp of Room. 73°-79°.
Sep. 19
Sep. 20


Infusion of leaves (conc.) injected into C, Sept. 21. Continued Sep. 22.
Comp. rabbit 20VIII.
C and 20VIII
C. died Sep 23.
Temperature Chart E
Temp. of Room. 75°-79°.
Temp of Room. 76°-80°
Sep. 21
Sep. 22

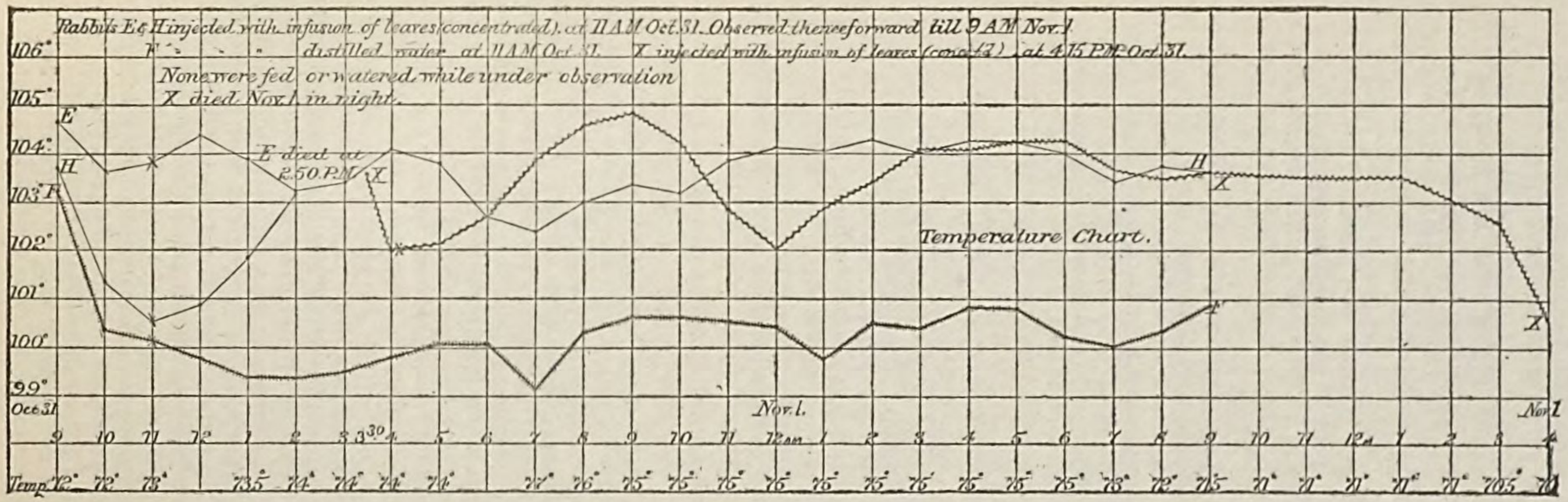

Infusion of leaves (conc.) injected Sep 21 into D.
Continued Sep. 22.
Comp rabbit 20VIII
D and 20VIII
C. Died Sep 23.
Temperature Chart F.
Temp. of Room. 75°-79°.
Temp of Room. 76°-80°.
Sep 21
Sep. 22

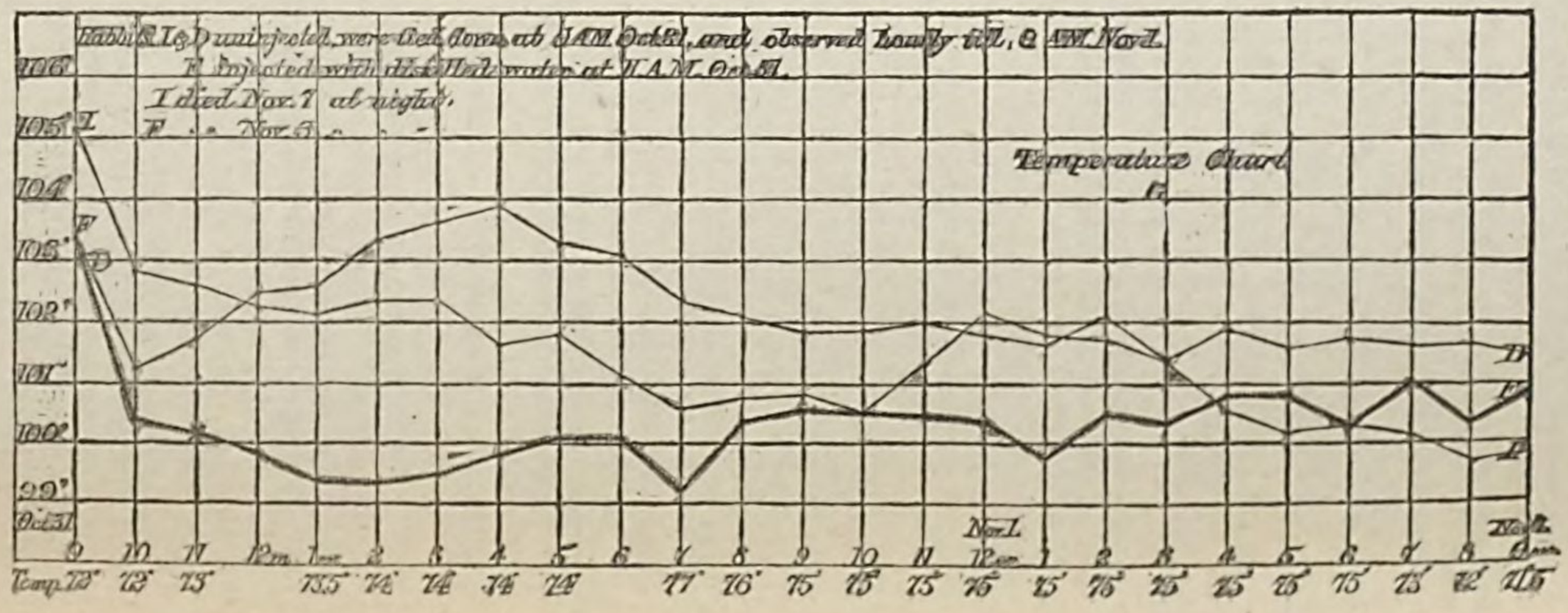
my record of water samples, I found that this particular sample had been prepared by the addition to good spring water of a simple aqueous infusion of dead forest leaves to an extent to form 5 per cent. of the whole. It seemed both to Dr. Martin and to myself desirable that the experiment should be repeated.

The original experiment had been made on May 23 and 24. In September I prepared a similar infusion of ordinary dead forest leaves, chiefly from oaks, but with some representation of several other trees, the strength of which may of course have differed considerably from that of the former sample, though it was prepared with about the same proportion of leaves and water. It was not diluted but sent to Dr. Hartwell, then in charge of the biological experiments, just as prepared. He was unable to use it for three or four days, during which time the bottle remained unopened. When experimented on it was described by Dr. Hartwell as dark-colored and turbid, containing a good deal of amorphous vegetable *débris*, and swarming with living bacteria and micrococci; contained also masses of hyphæ and a good many saccharomycetes in torula chains; bacterial organisms were more abundant in the concentrated than in the unconcentrated water. A "culture experiment" was without result. Two rabbits (A and B) were injected with the water just as received. (see temperature charts* C and D), but neither died until it had been injected with some other water. Two other rabbits (C and D) were injected on September 21 with the water concentrated by evaporation. They had less fever than A and B (see temperature charts E and F), but both died in the night of September 23. C had diffuse cellulitis with dark, purulent effusion, well marked in the left groin (the point of injection), and to a less degree in the right groin and the lower part of the abdomen. Patches of ulceration were noted in the mucous coat of the small intestine, and of the *appendix vermiformis*, and also a few rust-colored patches on the serous intestinal coat. The spleen was somewhat enlarged, dark in color, and soft. The lungs, on their upper surface, were much congested. The heart was somewhat congested, and contained dark clots. D showed very marked sanguinolent and purulent infiltration of the subcutaneous tissues in the left groin and lower part of the abdomen. The spleen was somewhat enlarged, darkened, softened, and rounded at the edges. The lungs, especially the right, were congested. The heart, not congested, contained fluid blood.

Still another experiment was made with a similar infusion at the end of October, at the time of the hourly observations for normal temperature. The infusion was again prepared anew, and in the same way as before, but not necessarily of just the same strength. Two rabbits (I and D), uninjected, were tied down at 9 a. m., on October 31, and their temperature observed hourly until 9 a. m. on November 1, during which time they were without food or water. Another animal (F) was similarly treated, save that it was injected with distilled water only at 11 a. m., October 31. The results of the temperature observations on these three are given in temperature chart G. Two other rabbits (E and H) were tied down at the same time with the above, but were injected with the concentrated infusion of dead leaves at 11 a. m., October 31. At 2 h. 50 m. p. m. E. died; and, to supply its place another (X) was tied down at 3 h. 30 m. p. m., and injected with the same leaf infusion at 4 h. 15 m. p. m. These animals, remaining without food or water, were also observed hourly as to temperature for 24 hours, the time being extended for X so as to make its period of observation the same with the others. The results are shown in temperature chart H, on which also the curve for F (injected with distilled water) is repeated. It will be seen that one of the uninjected rabbits exhibits a considerable rise of temperature for a few hours. The other, I, showing well-marked fall of temperature toward the end of the period of observation, probably from exhaustion, died a week later. F, injected with distilled water only, showing generally low and rather equable temperature, died after two days. Of the rabits which received the subcutaneous injection of dead-leaf infusion one (E) died in four hours, after a brief rise, followed almost immediately by the setting in of fall of temperature. The second (H) shows well-marked and continued fever, but recovered. The third (X) shows strongly-marked fever, with a notable remission for some hours, ending with extensive fall of temperature, and death a few hours later. On *post-mortem* examination of the uninjected rabbit (I), its mesenteric veins and those of its serous intestinal coat were found injected; its lungs were pink and uncongested; both auricles and the right ventricle contained clotted blood. In the case of F (injected with distilled water only), the bladder was full of urine, the mesenteric veins and those of the serous intestinal coat were injected, and the liver was large, dark and soft. Numerous dark spots of extravasated blood were observed in the wall of the stomach, lying apparently between the mucous and muscular coats. Both lungs and heart were slightly congested. In each of the cases (E and X) of the rabbits injected with the dead-leaf infusion there was noticeable infiltration of the connective tissue for a considerable space about the point of injection, and also marked hypostatic congestion of the lungs, and the right heart of each was filled with dark clotted

* The temperature charts for the original experiment of May 23–24 will be found in their place among the results for the main series of water samples.


Rabbits E & H injected with infusion of leaves (concentrated) at 11 A.M. Oct. 31. Observed thereforward till 9 A.M. Nov. 1
F " " distilled water at 11 A.M. Oct. 31. X injected with infusion of leaves (concd.) at 4.15 P.M. Oct. 31.
None were fed or watered while under observation
X died Nov. 1 in night.
E died at 2.50 P.M.
Temperature Chart.
106°
105°
104°
103°
102°
101°
100°
99°
Oct. 31
Nov. 1
Temp. 72° 72° 73° 73.5° 74° 74° 74° 74° 77° 76° 75° 75° 76° 76° 75° 75° 76° 75° 75° 75° 73° 72° 71.5° 71° 71° 71° 71° 71° 70.5° 70°


Rabbits I & D uninjected, were fed down at 11 A.M. Oct. 31, and observed hourly till 9 A.M. Nov. 1.
H injected with distilled water at 11 A.M. Oct. 31.
I died Nov. 1 at night.
F " Nov. 6
Temperature Chart
G
106°
105°
104°
103°
102°
101°
100°
99°
Oct. 31
Nov. 1
Nov. 2
Temp. 73° 73° 73° 73.5° 74° 74° 74° 74° 77° 76° 75° 75° 75° 75° 75° 75° 75° 75° 75° 75° 75° 75° 75°

blood. Bacterial organisms were found in the blood of each, but more abundantly and widely in that of X than of E.

Thus, out of nine experiments with this infusion of dead leaves, in the two cases in which it was used unconcentrated by evaporation we have fever without death, while in the remaining seven cases in which the concentrated water was used we have five deaths and two exhibitions of fever with recovery.

So far as these experiments, made upon rabbits and by the method of subcutaneous injection, can be admitted as evidence in regard to the wholesomeness or unwholesomeness of a drinking water to be swallowed by human beings, it is plain that they do not favor the idea that vegetable organic matter may be disregarded as harmless. That we may well accept as probable that the mischief done was not attributable to this original organic matter *per se*, but to the bacterial or other organisms developed during its chemical change, does not touch the main practical point suggested, which is rendered the more striking by the fact that in these experiments the particular form of organic contamination was such as ordinary drinking water of surface origin not only may, but must, be extensively exposed to, particularly in this still largely forest-covered country. Every one who has noticed in the woods the shallow pools of water standing after rain in hollows filled with dead leaves through a large portion of the year, and has seen this water washed away by a moderate additional shower, has seen just such material carried into the drainage channels of the country as yielded the results of the experiments now recorded. How much dilution, and how much efficient oxidation by dissolved and atmospheric oxygen such material may undergo before the water is used for drinking purposes, is of course another question, the answer to which, if attainable, would vary enormously in different localities.

INJECTION EXPERIMENTS WITH SOLUTIONS OF POTASSIUM AND AMMONIUM NITRITES.

In connection with the question of the significance of nitrates and nitrites when found in drinking water, most sanitary authorities seem to consider it as settled that these salts are of themselves quite harmless, and that their importance depends simply upon their furnishing evidence of past contamination by decomposing nitrogenous organic matter. As regards such nitrates, and in such quantity as any natural water is liable to contain, our knowledge of their physiological action is doubtless sufficient to fully acquit them of any inherently injurious character, but it does not seem quite certain that as much can be said in regard to the nitrites. So far as direct experiments upon living animals have been made by physiologists with the latter class of salts, the results have been rather of an unfavorable character. The number of investigators in this direction does not seem to be large. In 1867 and 1868 Gamgee * examined the action of nitrites upon solutions of hæmoglobin and upon blood, and found that the absorption spectrum of hæmoglobin was changed in a special way, and that the respiratory or loosely combined oxygen became incapable of removal by carbon monoxide or by exposure in a Torricellian vacuum. The spectral phenomena presented by such altered hæmoglobin were further examined by Sorby,† Lankester,‡ and Jäderholm.§ More recently Reichert and Weir Mitchell‖ experimented with potassium nitrite on man and several of the lower animals, and observed acceleration of pulse, flushing of the face, throbbing in the head, depressent effect on the nerve centers and nerves, stimulation followed by depression of respiration, slight rise followed by more marked lowering of bodily temperature, and local irritant effect. The general conclusion of Reichert is that the action of potassium nitrite, and, as far as his experiments went, the sodium salt also produced essentially the same effects as amyl nitrite, but in more lasting form. The doses used were large – for man from 2 to 10 grains at a time, running up to 35 grains in a single day. Binz¶ has still more recently worked with sodium nitrite, experimenting on frogs, dogs, and rabbits. In some of his experiments .150 gram of the salt was injected subcutaneously into a rabbit, in three portions, in the course of eight hours. On *post mortem* examination ecchymoses were found in the pyloric portion of the stomach; its fundus was reddened; the whole mucous membrane of the stomach was injected and swollen; and there was marked abdominal plethora. He determined that paralysis supervened in frogs, poisoned by this salt, *before* the peculiar appearances described by Gamgee and others, due to nitrites in the blood, could be seen. He came to the conclusion that sodium nitrite has a caustic effect like that of arsenic, and that it paralyzes the nervous system, beginning at the brain, without previous noticeable agitation.

All of these experiments probably refer to the use of nitrites in much larger quan-

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* Proc. Roy. Soc., Edinb., 1867; 168. Philos. Trans., 1868; 589.

† Quart. Jour. Microsc. Sci., 1870; 400.

‡ Jour. of Anat. and Phys., IV; 123.

§ Maly's Jahresb., VI; 85. All of these references are from Gamgee's Text Book of Physiolo. Chem. (1880), I; 109.

‖ Amer. Jour. of Med. Sci., July, 1880; 158.

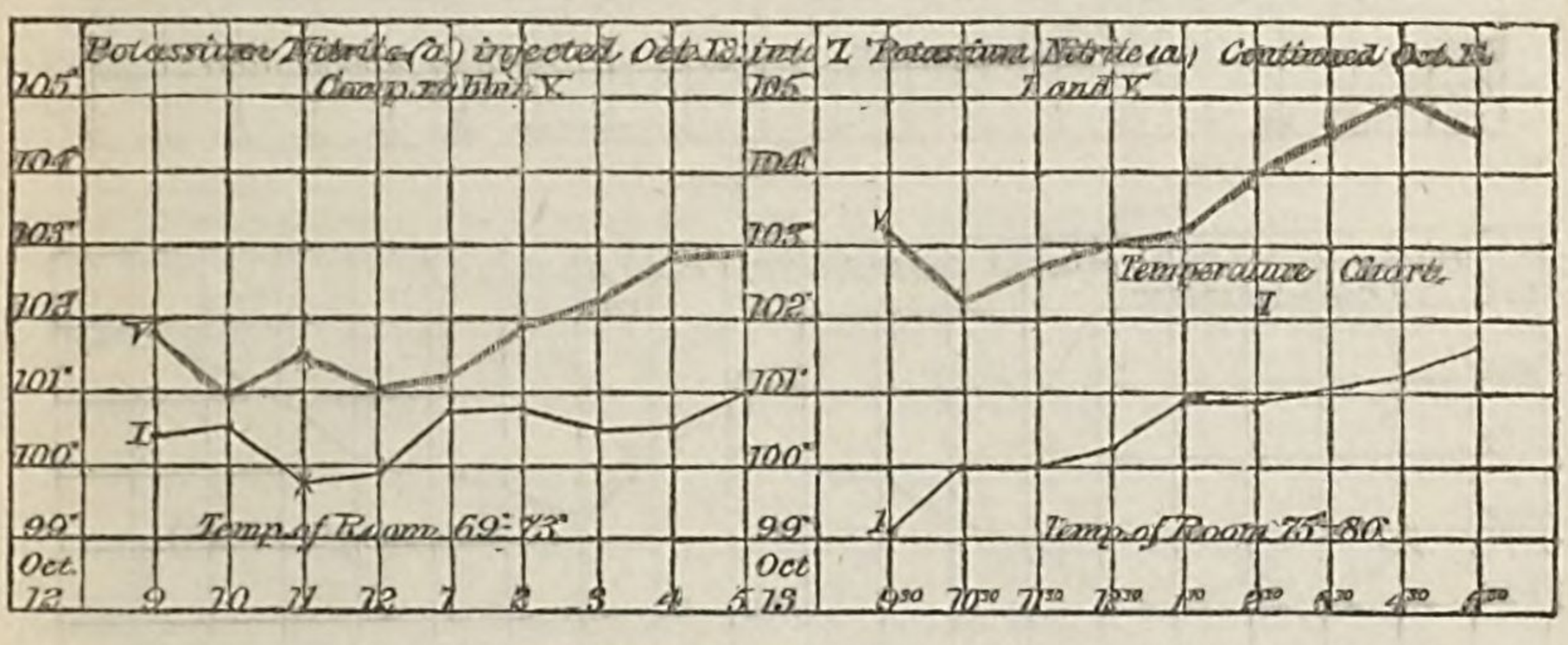
¶ Archiv für exper. Pathol. u. Pharm. (1880), XIII; 132.

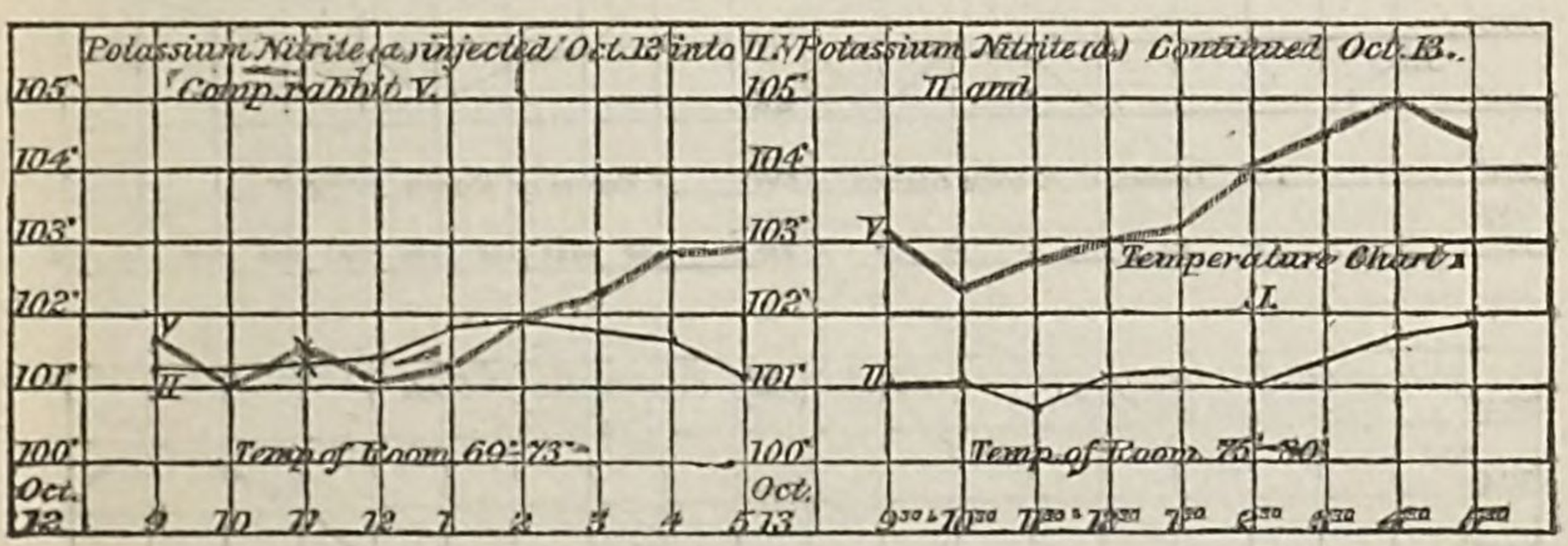
tities than could be introduced by the use of any drinking water likely to be encountered. Hence, although it seemed unlikely that any very decided results were to be expected from injection experiments, made with very dilute solutions, such as those with which water analysis is concerned, it was determined to try a few such experiments near the close of the work. Previous workers do not state how their alkaline nitrites were prepared, and the references to local irritant or caustic action by Reichert and Binz suggest the question whether heating the corresponding nitrates was resorted to, and if so whether sufficient care was taken to remove by repeated crystallizations all trace of alkaline oxide or hydrate. For the purpose of the experiments now to be described weighed portions of a pure silver nitrite were exactly decomposed by equivalent amounts of the chlorides of potassium and ammonium, and thus, after filtration and dilution to required volume, solutions of potassium and ammonium nitrites were obtained, containing in each case:

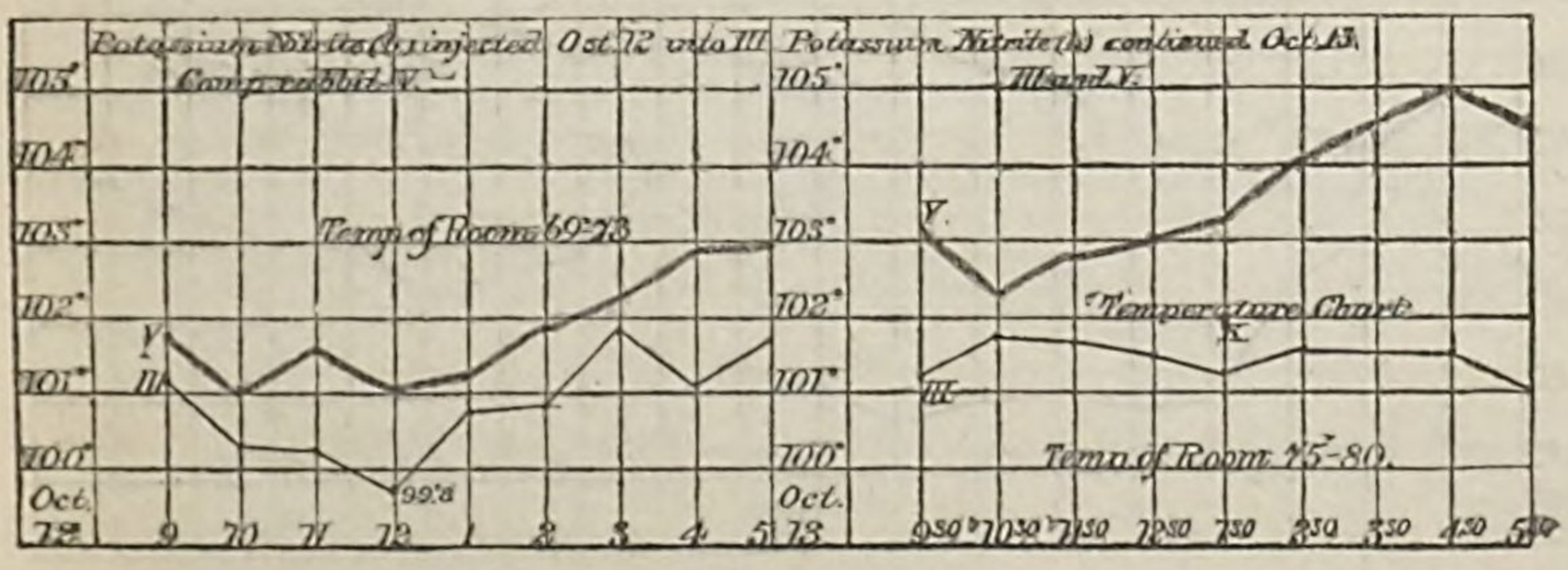
a. 10 mgrms. of nitrogen per liter of water.
b. 20 mgrms. of nitrogen per liter of water.
c. 50 mgrms. of nitrogen per liter of water.
d. 100 mgrms. of nitrogen per liter of water.

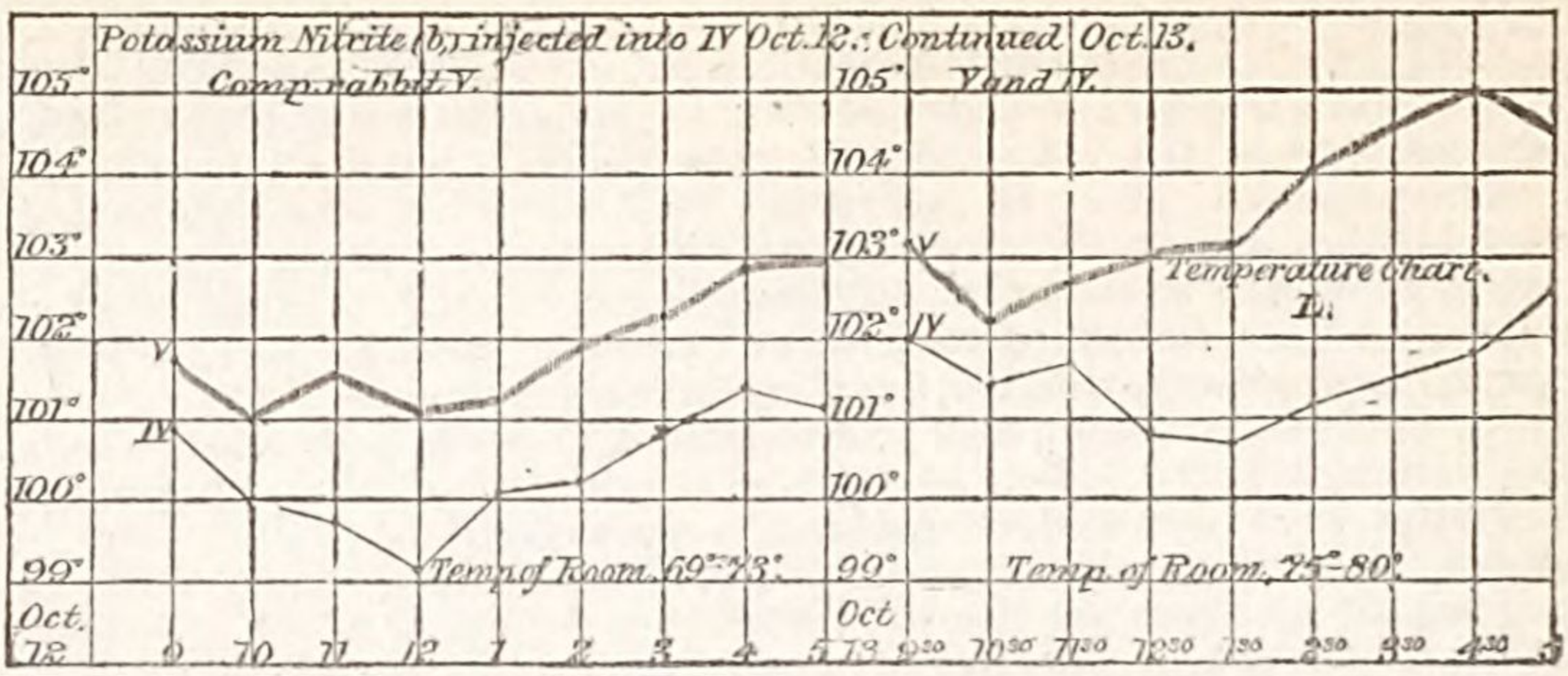
In each of the two sets of experiments made nine rabbits were used. In the first set I and II were injected with a solution of potassium nitrite of the strength (*a*), III and IV with same solution (*b*), VI and VII with same (*c*), and VIII and IX with same (*d*), while the comparison rabbit V received an injection of simple distilled water.

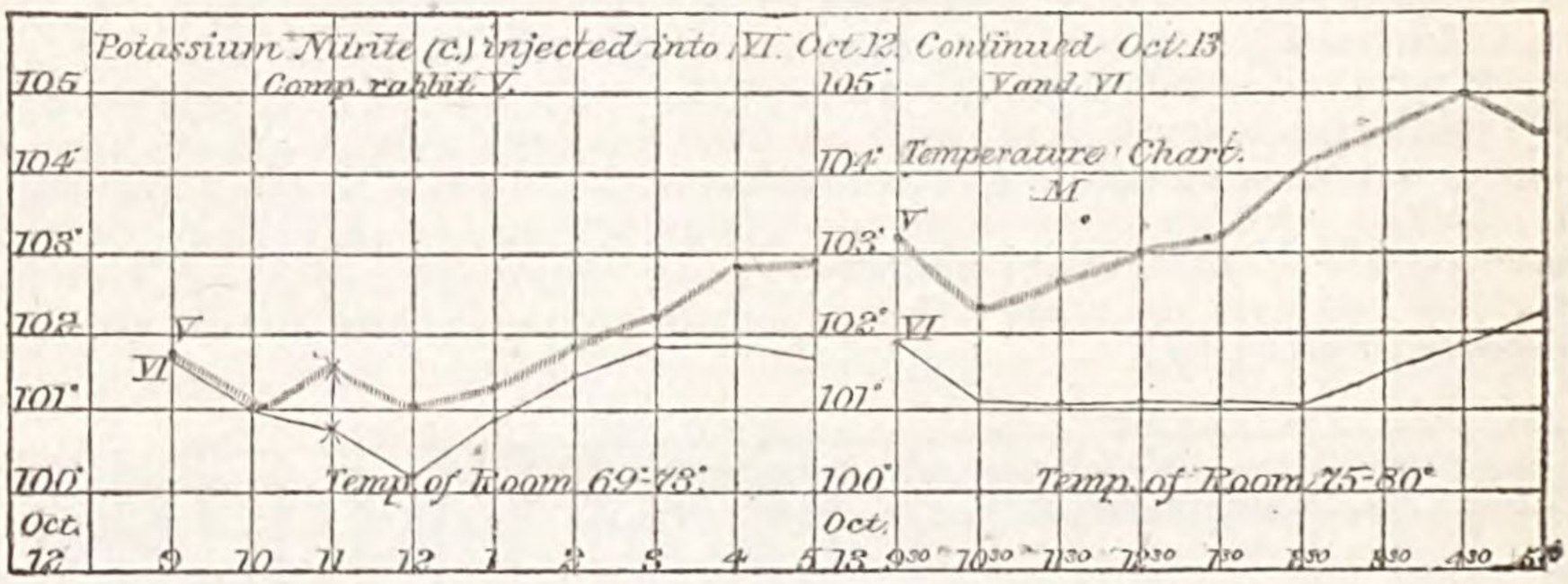
In the second set ammonium nitrite was substituted for the potassium salt, I and III receiving an injection of strength (*a*), IV and V (*b*), VI and VII (*c*), VIII and IX (*d*), the comparison rabbit being numbered II and reciving distilled water only. The results of the temperature observations upon the animals thus treated are shown in Temperature Charts I to X:

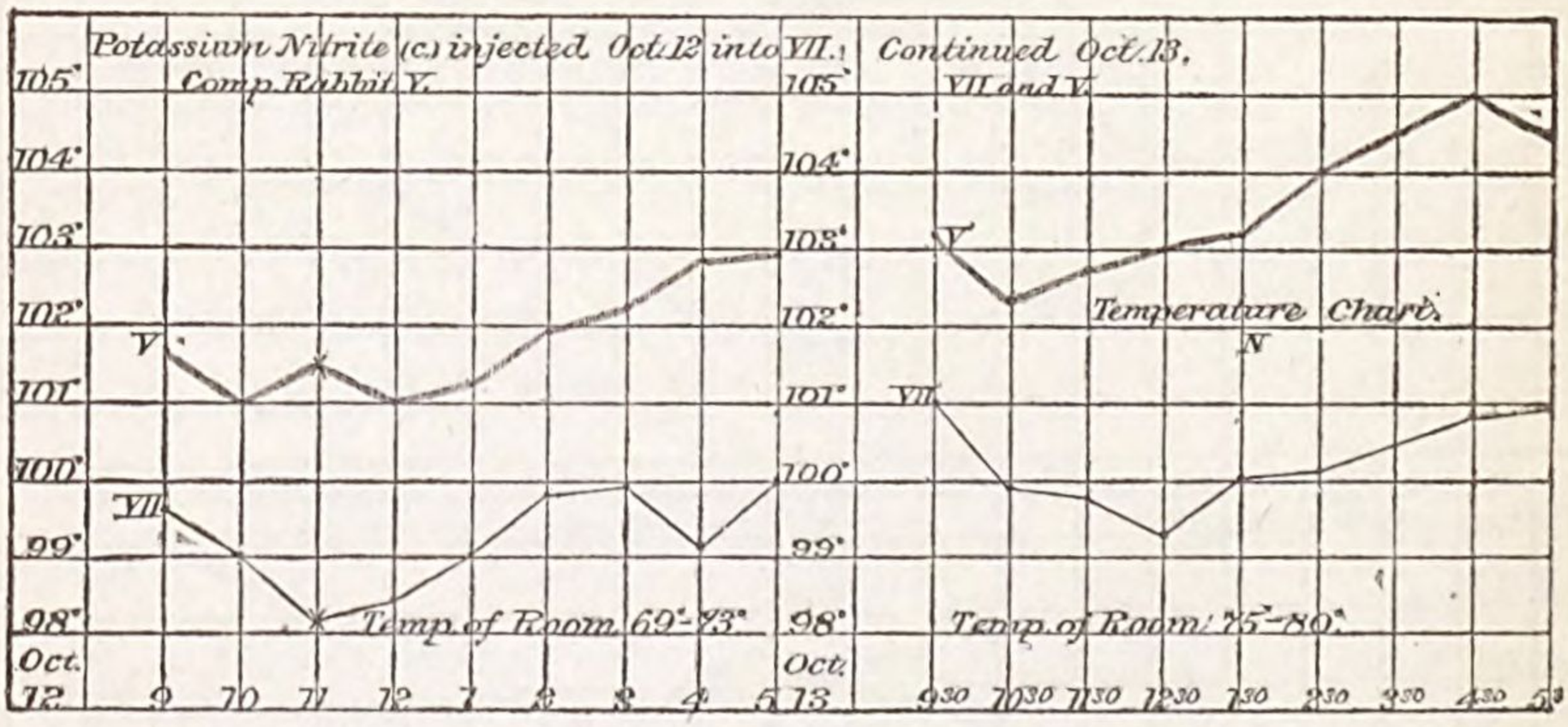


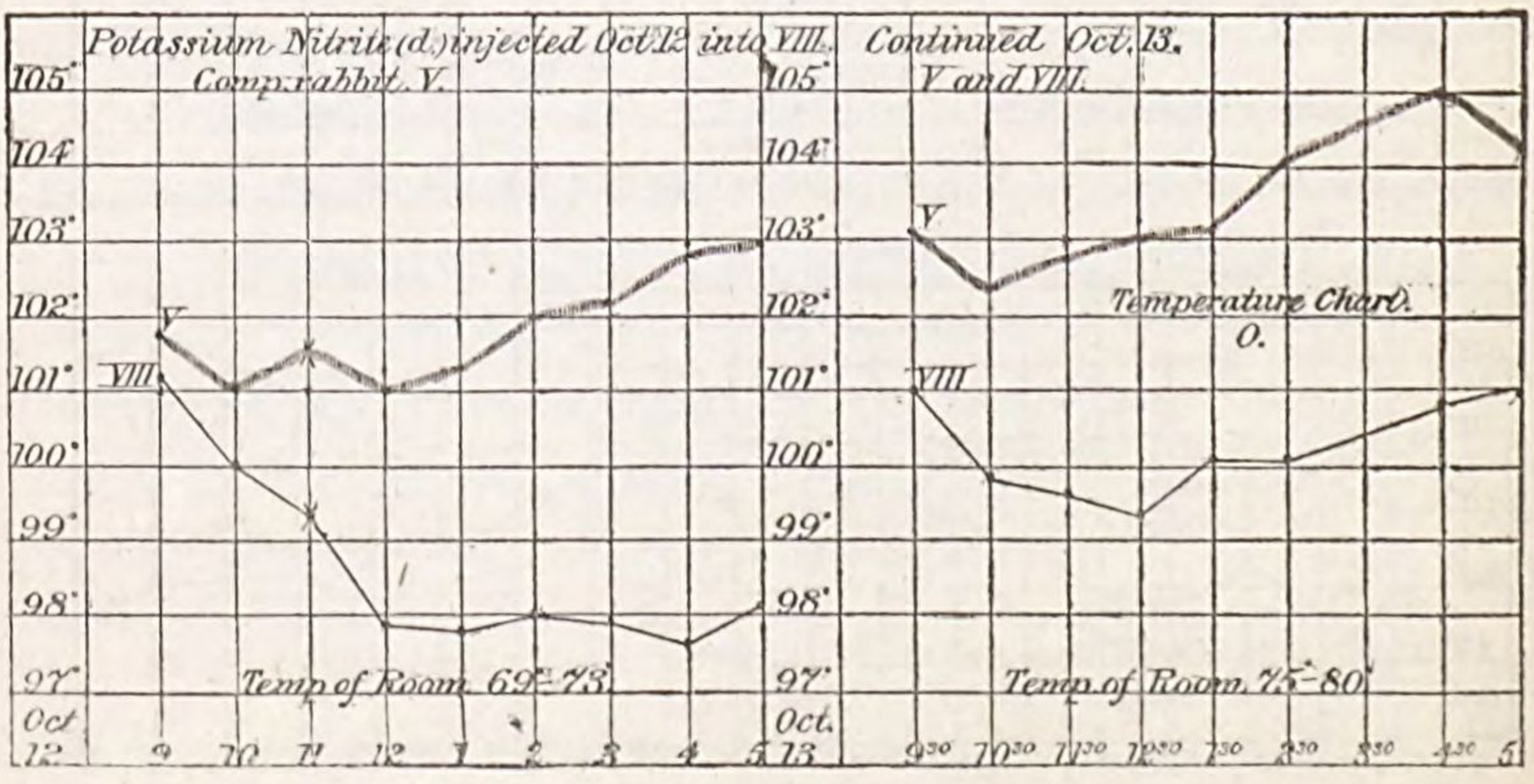


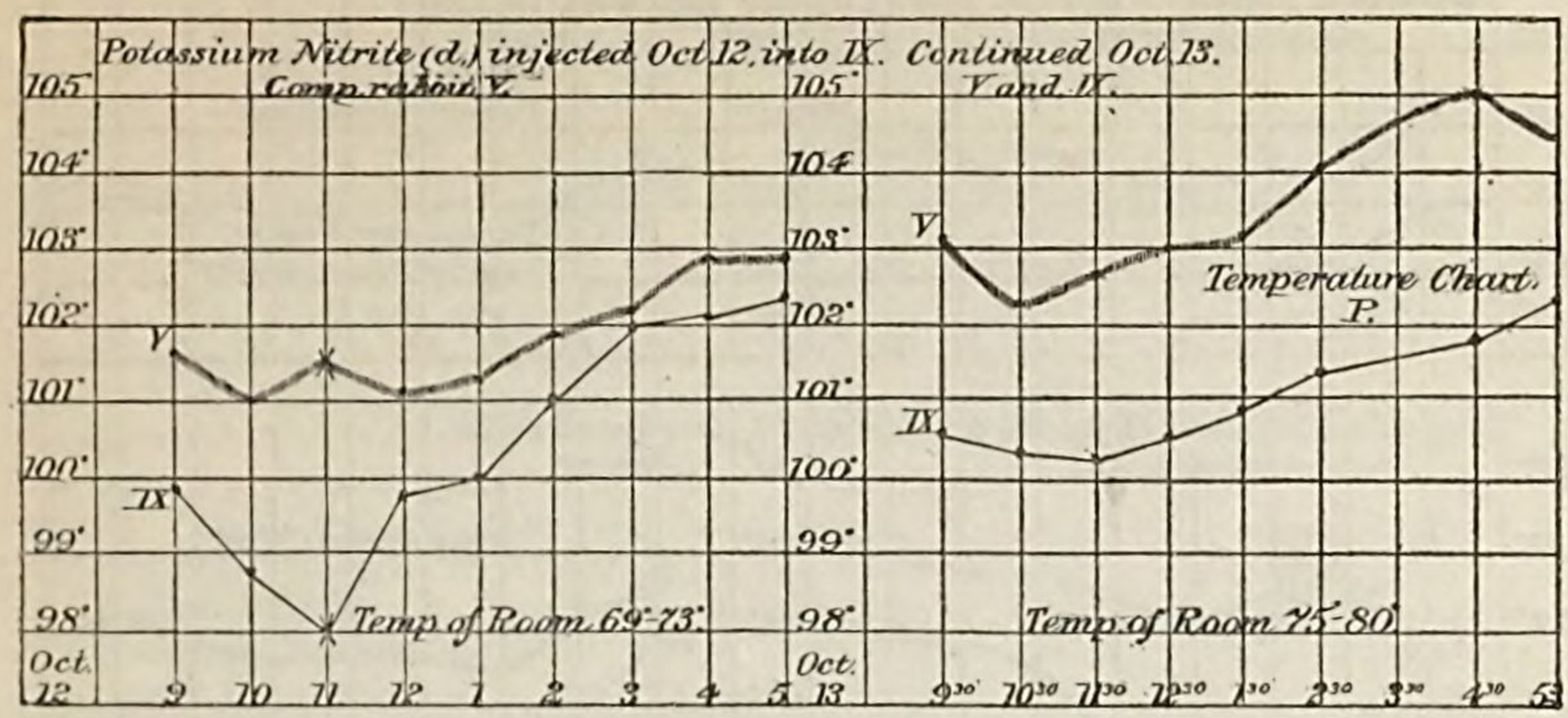


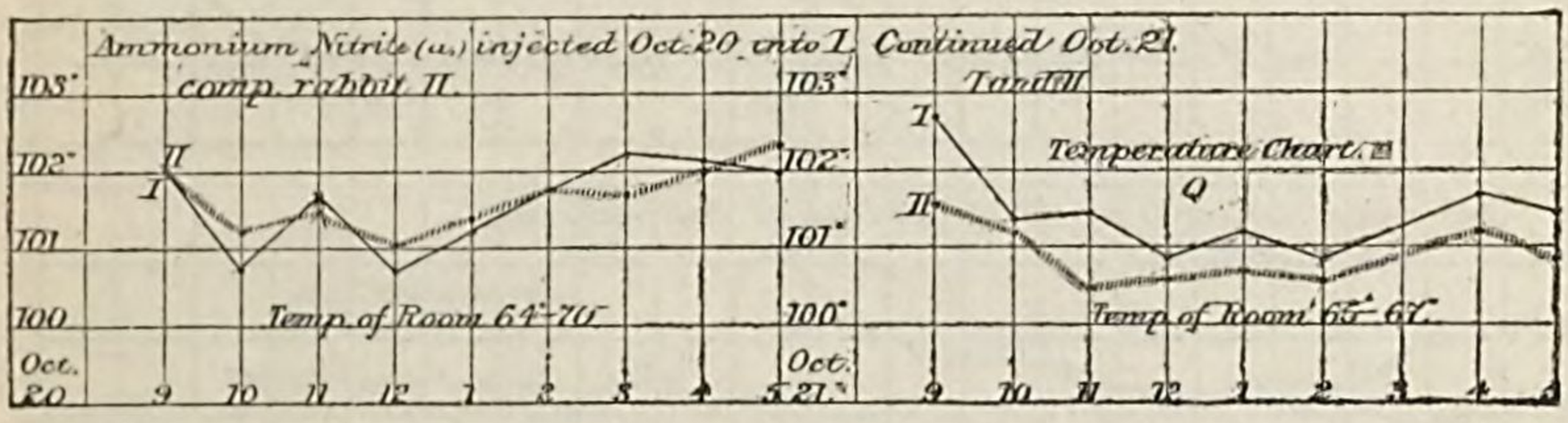

Potassium Nitrite (b) injected into IV Oct. 12.: Continued Oct. 13.
Comp. rabbit V.
V and IV.
Temperature Chart.
IV.
Temp of Room. 69°-73°.
Temp. of Room. 75°-80°.
105°
104°
103°
102°
101°
100°
99°
Oct. 12
Oct 13
9 10 11 12 1 2 3 4 5
9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30

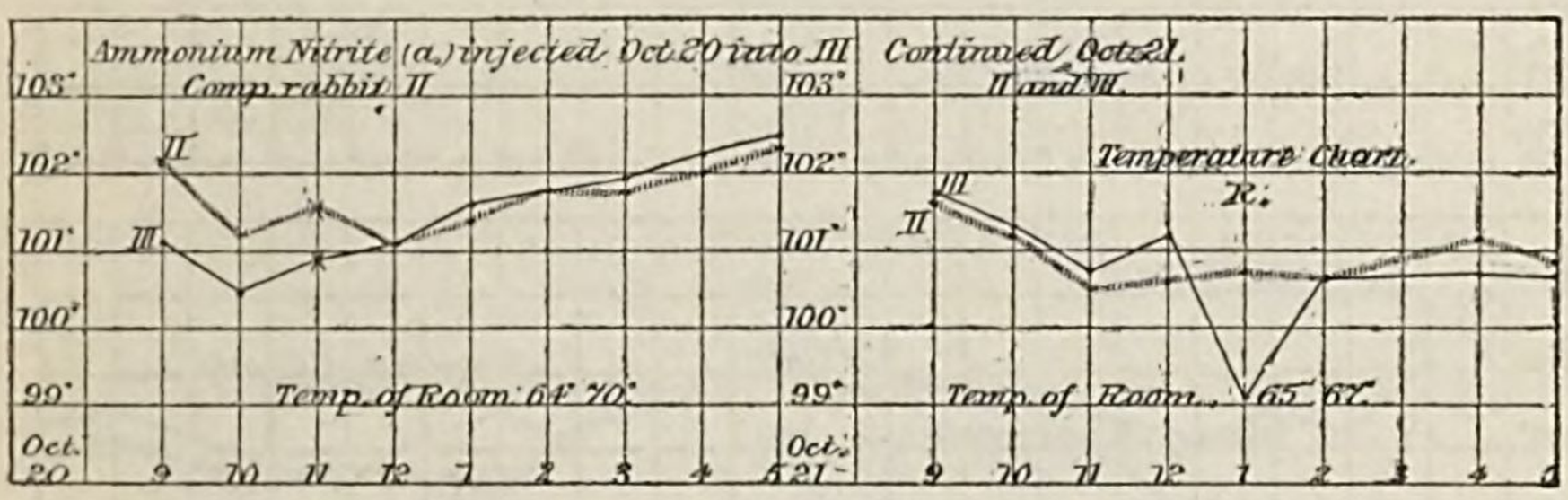

Potassium Nitrite (c.) injected into VI. Oct 12. Continued Oct. 13.
Comp. rabbit V.
V and VI.
Temperature Chart.
M.
Temp of Room 69°-73°.
Temp. of Room 75-80°.
105°
104°
103°
102°
101°
100°
99°
Oct. 12
Oct. 13
9 10 11 12 1 2 3 4 5
9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30

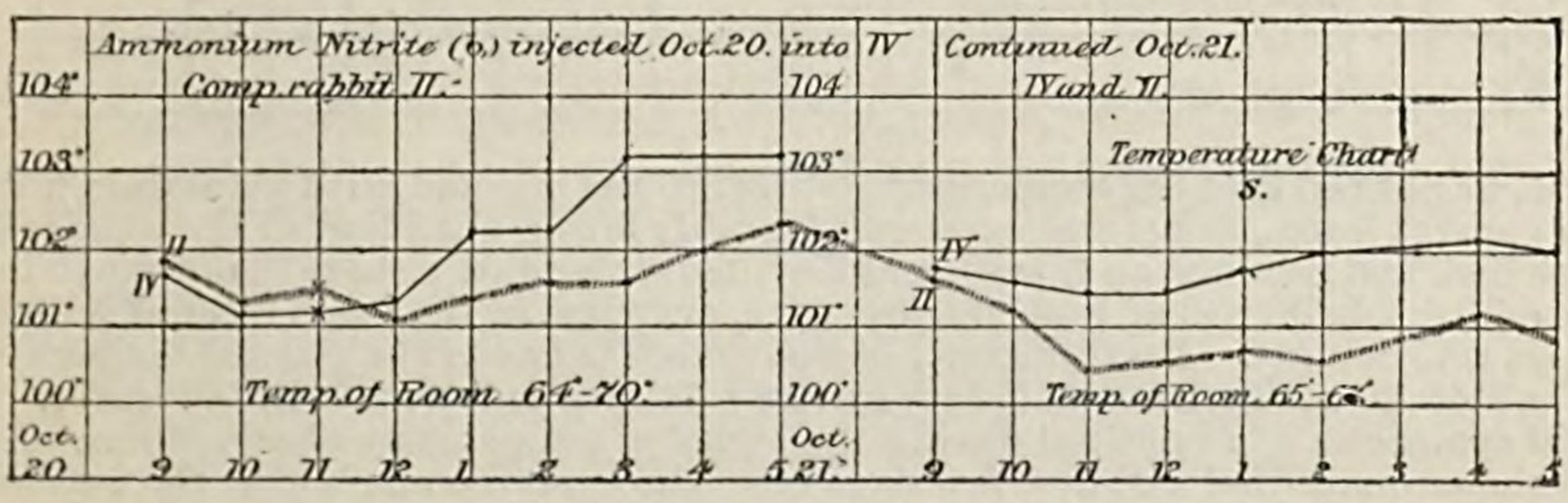

Potassium Nitrite (c.) injected Oct. 12 into VII.: Continued Oct. 13.
Comp. Rabbit V.
VII and V.
Temperature Chart.
N.
Temp. of Room 69°-73°.
Temp. of Room 75-80°.
105°
104°
103°
102°
101°
100°
99°
98°
Oct. 12
Oct. 13
9 10 11 12 1 2 3 4 5
9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30

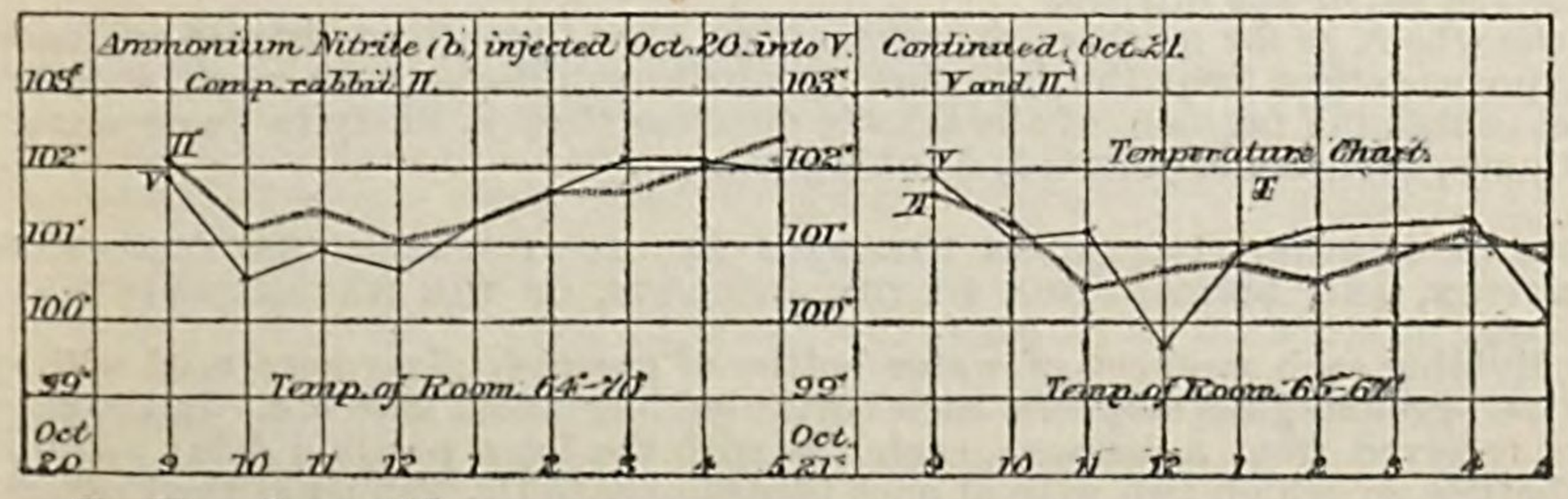

Potassium Nitrite (d.) injected Oct. 12 into VIII. Continued Oct. 13.
Comp. rabbit V.
V and VIII.
Temperature Chart.
O.
Temp of Room 69°-73°.
Temp of Room 75°-80°.
105°
104°
103°
102°
101°
100°
99°
98°
97°
Oct. 12
Oct. 13
9 10 11 12 1 2 3 4 5
9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30

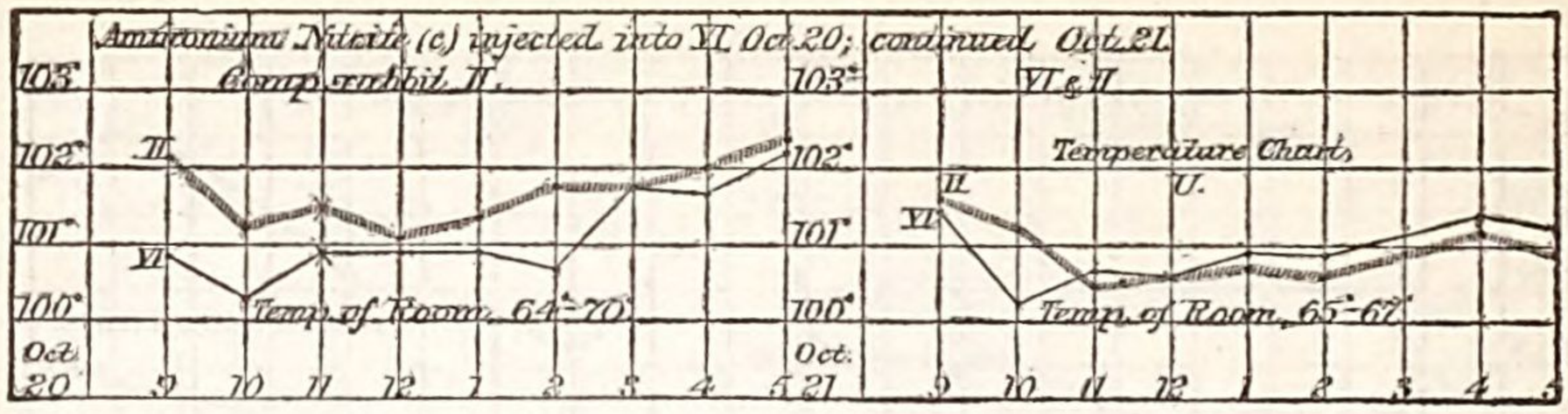

Potassium Nitrite (d.) injected Oct. 12, into IX. Continued Oct. 13.
Comp. rabbit V.
V and IX.
105°
104°
103°
102°
101°
100°
99°
98°
V
IX
Temp. of Room 69°-73°.
Temp. of Room 75°-80°
Temperature Chart. P.
Oct. 12
Oct. 13
9 10 11 12 1 2 3 4 5
9:30 10:30 11:30 12:30 1:30 2:30 3:30 4:30 5:30

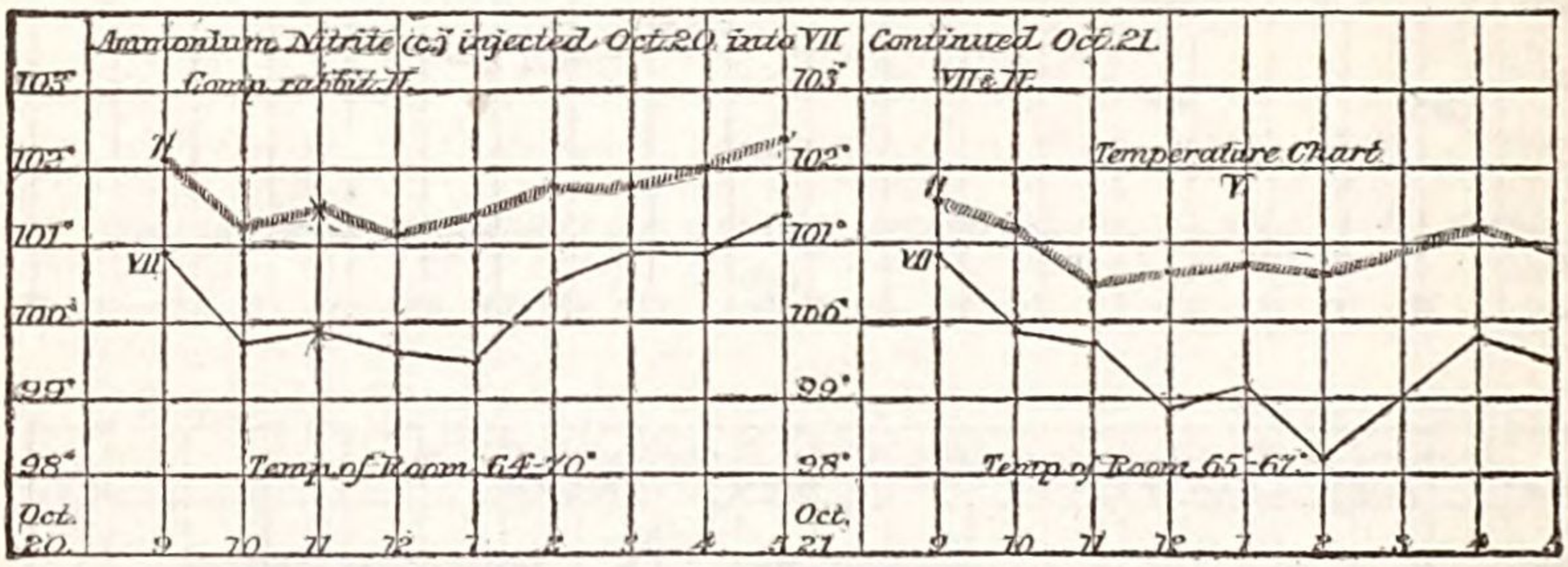

Ammonium Nitrite (a.) injected Oct. 20 into I. Continued Oct. 21.
Comp. rabbit II.
I and III
108°
103°
102°
101°
100°
II
I
III
Temp. of Room 64°-70°
Temp. of Room 65°-67°
Temperature Chart. Q
Oct. 20
Oct. 21
9 10 11 12 1 2 3 4 5

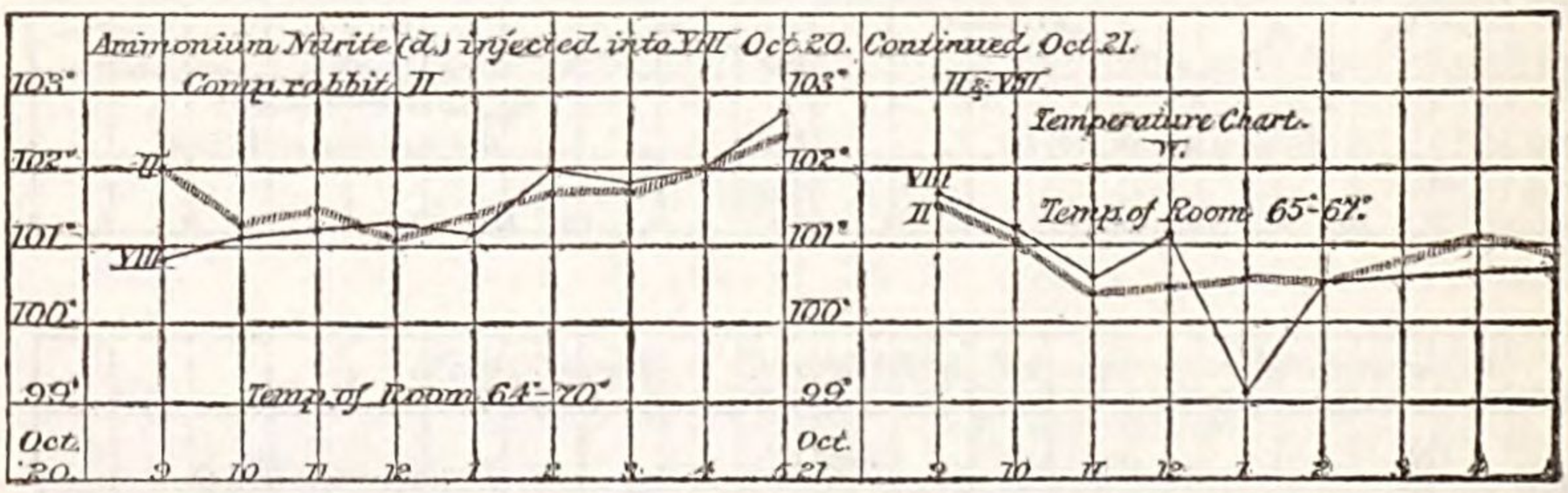

Ammonium Nitrite (a.) injected Oct. 20 into III Continued Oct. 21.
Comp. rabbit II
II and III.
108°
103°
102°
101°
100°
99°
II
III
Temp. of Room 64°-70°
Temp. of Room 65°-67°
Temperature Chart. R.
Oct. 20
Oct. 21
9 10 11 12 1 2 3 4 5

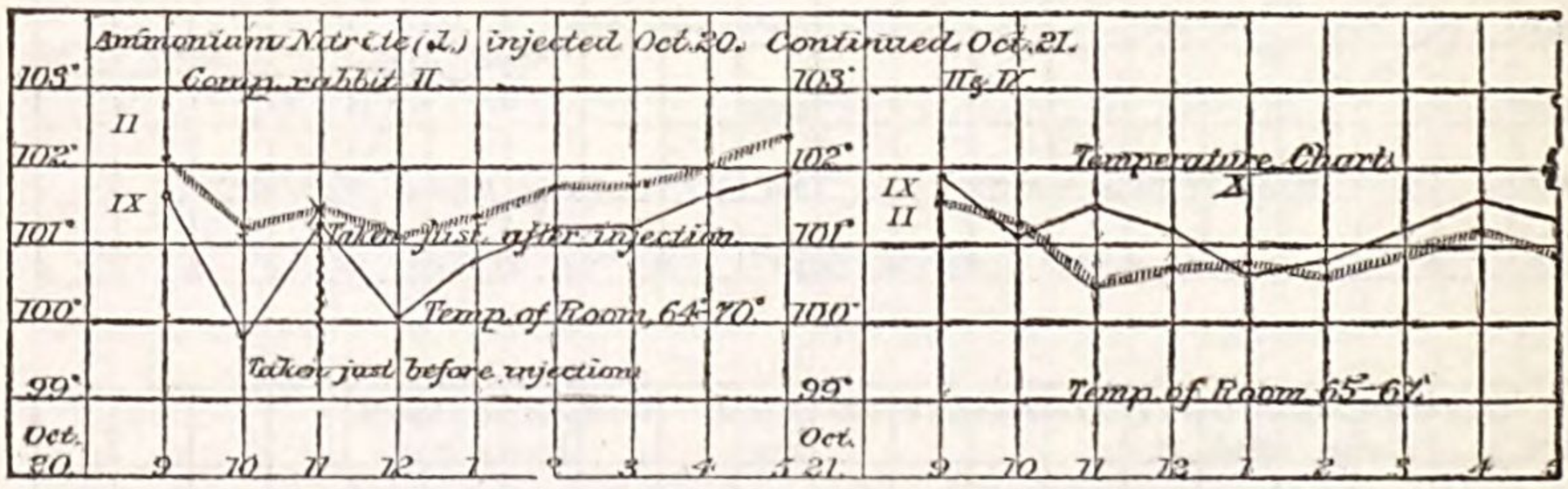

Ammonium Nitrite (c.) injected Oct. 20. into IV Continued Oct. 21.
Comp. rabbit II.
IV and II.
104°
103°
102°
101°
100°
II
IV
Temp. of Room 64°-70°
Temp. of Room 65°-67°
Temperature Chart S.
Oct. 20
Oct. 21
9 10 11 12 1 2 3 4 5


Ammonium Nitrite (b.) injected Oct. 20. into V. Continued Oct. 21.
Comp. rabbit II.
V and II.
108°
103°
102°
101°
100°
99°
II
V
Temp. of Room 64°-70°
Temp. of Room 65°-67°
Temperature Chart T
Oct. 20
Oct. 21
9 10 11 12 1 2 3 4 5









It will be noticed that the temperature of the rabbits injected with potassium nitrite was in general lower, in several cases considerably lower, than that of the comparison rabbit which had received an injection of distilled water only; there is not much indication of any febrile rise of temperature, save, perhaps, in the cases treated with the strongest solution (*d*). Less difference is observable between the general temperature of the rabbits treated with ammonium nitrite solutions and with distilled water. No unusual symptoms were noticed during the period of temperature observations. Several of the animals died within a few days after the experiments, but in the autopsies made Dr. Hartwell failed to find any lesions which he could consider fairly attributable to the use of the nitrites.

On the whole, as far as these experiments go, they furnish no distinct evidence of any injurious effect from the injection of nitrite solutions—very weak, it is true, but yet containing far more of the salts in question than is likely to be encountered in ordinary, even much polluted, drinking water.

DETAILS OF METHOD PURSUED IN THE MAIN SERIES OF WATER ANALYSES—PREPARATION, AND DISTRIBUTION TO THE ANALYSTS, OF THE WATER SAMPLES.

For dividing each specimen of water bottles of greenish glass were used with specially well-ground glass stoppers, each bottle holding about 2500 c. c. In the case of waters received from a distance, each was with the least possible delay put up in these bottles, of which two were at once turned over to Dr. Tanner at the University

of Virginia, two were sent to Dr. Smart at Washington, two more to Mr. Noyes at Baltimore, and with these last a third bottle for Professor Martin, or, later in the year, Dr. Hartwell, for the biological observations.* The vessels in which the water originally came were not shaken up, but in order to insure uniform distribution of any very fine suspended matter which might be present, it was arranged that each analyst should thoroughly shake up the bottles sent him just before drawing off the portions actually used for analysis. To guard against the possibility of any difference between the contents of the (two) vessels received from the original source, the bottles for the analysts were filled in equal proportions from these two. To guard against any difference in character or extent of change in the water from variable exposure to light, it was arranged that the bottle should always be kept in darkness until the analytical determinations were complete. The bottles were almost completely filled, leaving merely space of a few c. c. in case of expansion from change of temperature. The stoppers were tied down firmly, and the bottles for Washington and Baltimore were packed in boxes specially made for them, but one kind of water to a box. Each bottle for Dr. Tanner, and each box sent away, was marked with an arbitrarily selected number, a different one for each of the three analysts, a list of these, and of the waters they referred to, being kept by myself. The boxes were shipped through Adams Express Company, and, in order to allow of their being certainly delivered in time for simultaneous examination by all three analysts, it was arranged that the examination of each sample should be made on the next day but one after it was shipped. It may be mentioned that although there were a few cases of breakage of a single bottle in a box, and a few cases of slight delay in delivery, there was not a single analysis lost from either cause, or a single failure to secure simultaneous examination. The shipment of each water was made in the afternoon, one each day,† and by the same train that carried the boxes there went postal cards to the analysts in Washington and Baltimore, quoting the designating numbers of the water sent, and noting the day on which it was to be examined. The results of examination were reported to me (by the assigned numerical marks) daily by mail, on printed forms giving all the original readings (as of gaseous volume, temperature, pressure, &c.), as well as the calculated results, so that the calculations admitted of being verified. As soon as the bottles were emptied they were sent back to me by express, and before being used again were thoroughly washed out, rinsing either with distilled water or with the specimen of water to be next shipped, always the latter in the case of the bottle to contain water for microscopical and biological examination. If any sign of visible film appeared upon the inner surface of a bottle it was washed out with a mixture of nitric, hydrochloric, and strong sulphuric acid, and then rinsed with abundance of water. In the case of suspected or doubtful waters received, I myself made a careful examination for poisonous metals or any strong acid or alkaline reaction, so that such causes of unwholesomeness, distinct from the presence of organic matter or its concomitants, should not be overlooked. No such impurity, however, was detected.

ANALYTICAL METHODS PURSUED.

In order to fairly test the chief processes to be examined, it was deemed best to depart in no essential respect from the detailed directions of Frankland, Tidy, and Wanklyn, respectively. It will be well, however, to state pretty accurately how each process was carried out. In connection with the combustion process, Mr. Noyes had the advantage of obliging communications to him from Prof. W. R. Nichols, of the Massachusetts Institute of Technology, and from his former assistants in the use of this process, Messrs. Hardman and MacFarlane, the former of whom worked by means of it in Frankland's laboratory. Before entering upon the actual analytical work, there was a careful calibration of all the graduated vessels—gas-tubes, measuring-flasks, pipettes, burettes, &c.—used for measurement. As regards the subordinate determinations, the methods for obtaining which it was not the special object of this inquiry to examine, what were on the whole believed to be the best and most accurate processes were adopted; what these were will be briefly mentioned.

OBSERVATION OF TINT, AND DEGREE OF CLEARNESS OR TURBIDITY, IN WATER (DR. TANNER).

A stout tube of white glass 62 c. m. long and 5 c. m. in diameter inside was closed at one end by a piece of colorless plate-glass cemented into a brass cap. This tube was supported in a vertical position, with the closed end downwards, inside a square wooden tube, blackened inside, which fitted it loosely. The whole was supported at a convenient height from the floor on a light wooden stand, open on one side, with a sloping shelf, covered with white paper, about 25 c. m. below the lower end of the tube, and at an angle of 45° with its axis. A round hole in the top of the stand, of same diam-

*These quantities of water were more than was actually needed; allowance was made for possible breakage of a bottle.

† As soon as the necessity for *duplicate* analyses by the combustion process became evident, it was seen that but one water could be disposed of daily.

eter with the inside of the glass tube, admitted diffused daylight, reflected from the white paper. A cap over the top of the wooden tube or box had a round hole in the center, 4 c. m. in diameter, through which could be observed the appearance of the water, which was poured in in sufficient quantity to stand 61 c. m. deep in the glass tube. This is essentially the arrangement used by Tidy. The tint was noted as blue, green, yellowish-green, yellowish, &c., and the appearance as regards suspended matter was recorded under the following descriptive heads:

Clear, when no solid matter could be detected on examination in this 2 foot tube.

Very slightly turbid, when sediment could be detected only by examination in this tube.

Slightly turbid, when a little suspended matter could be seen in the water in an ordinary beaker or bottle, and was very noticeable in the tube.

Turbid, when a considerable amount of sediment was observable without using the 2-foot tube, but it was possible to see through the tube without much difficulty.

Very turbid, when a large amount of sediment was present, and it was difficult or impossible to see through the tube.

ODOR.

In the case of waters presenting any perceptible odor, this was noted by both Dr. Tanner and Dr. Smart. The latter shook the water well in a half-filled bottle before observing the odor.

DETERMINATION OF TOTAL AMOUNT OF SOLID MATTER (DR. SMART).

This determination was not a matter of prime importance; for the present purpose 100 c. c. of water was evaporated in a small platinum capsule on a water bath at 100° C., and the residue was weighed without drying in an air-chamber. This is essentially according to Wanklyn's practice. The weight of the capsule was in no case taken for granted from previous use; it was cleaned out in every instance, ignited, and weighed after the loss which the residue suffered on ignition had been determined.

CHANGE OF APPEARANCE AND LOSS OF WEIGHT ON IGNITION OF WATER RESIDUE (DR. SMART).

Although it is well known that the loss of weight experienced by a water residue on ignition has no necessary connection with the amount of organic matter present, and indeed may vary from the presence of substances which have but little bearing on the wholesomeness of the water, Dr. Smart himself, after large experience, is inclined to attach importance to the appearance of the eschar and the circumstances attending the ignition, such as the degree of blackening, ease or difficulty with which it is dissipated, evolution of ammoniacal or nitrous fumes, or of nitrogenous odors, like that of burnt feathers, these constituting, in his opinion, the simplest and readiest rough test of quality, and the most trustworthy when a thorough examination cannot be had. He wished to see how far this opinion would be borne out by the records of this investigation. He ignited at a gentle red heat, gradually attained, and weighed the ignited residue in the same capsule which had been used for the evaporation.

CHLORINE (DR. SMART).

Chlorine was determined volumetrically, using a silver nitrate solution of which 1 c. c. =1 mgrm. of Cl. In the early part of the research potassium chromate was used as indicator; later during the examination of the thio-cyanate process, this was employed in cases in which there was much organic matter giving considerable color, while the chromate was used for such waters as were free from color, and in several cases where a large amount of organic matter was present the chromate was used after ignition of the residue. After the value of the thio-cyanate process had been fully recognized, this was always used if the water before or after concentration showed any color, or if organic matter adhered to the bottom of the evaporating capsule; but if the water or the product of its concentration was clear and colorless, the chromate was employed. Fifty c. c. of the original water was used if this quantity was sufficient to give recognizable results; if not, a larger volume of water was concentrated by evaporation. In a few cases the sample had to be evaporated to dryness, the residue gently charred, and chlorine determined in the filtered lixiviate.

ORGANIC CARBON AND NITROGEN BY COMBUSTION PROCESS (MR. NOYES).

The method was in all essential particulars that of Frankland, as given in his little treatise on "water analysis for sanitary purposes" (1880), but the following notes by Mr. Noyes give the special features of his personal experience:

I.—REAGENTS.

1. *Pure water* distilled, was heated to 100° C., with alkaline potassium permanganate for twenty-four hours, the liquid acidfied with sulphuric acid heated for twenty-four hours more, and then distilled in glass vessels, a few scraps of silver foil being added to prevent bumping.

2. *Sodium acid sulphite.*—This reagent at first caused more trouble than any other, owing to the difficulty of obtaining sodium carbonate free from organic matter; recrystallization of the sodium carbonate was finally resorted to. It is important that the neutral salt be not left to any considerable extent at the close of the evaporation with sulphurous acid; in a few cases, in which the salt had to be largely used, the presence of neutral sulphite in the residue made it difficult to dry, and a drop or two of dilute hydrochloric acid was added to decompose the sulphite and form sodium chloride, but the practice is not to be recommended.

3. *Cupric oxide.*—Copper scale was mixed with 10 per cent. of pulverized potassium chlorate and a little water in an iron crucible, the mixture dried, ignited in a gas furnace till the chlorate was fully decomposed; the residue washed free of potassium chloride, dried, melted in a covered Hessian crucible in a charcoal furnace, broken up in an iron mortar; the fine portion sifted out through wire-gauze, and the coarse heated for 2 or 3 hours in an iron tube as Frankland directs. Some trouble was encountered with a new lot of the oxide until it had been used in the vacuum. For greater accuracy in the final experiments on water containing determined amounts of pure chemicals, the cupric oxide was recalcined for every combustion.

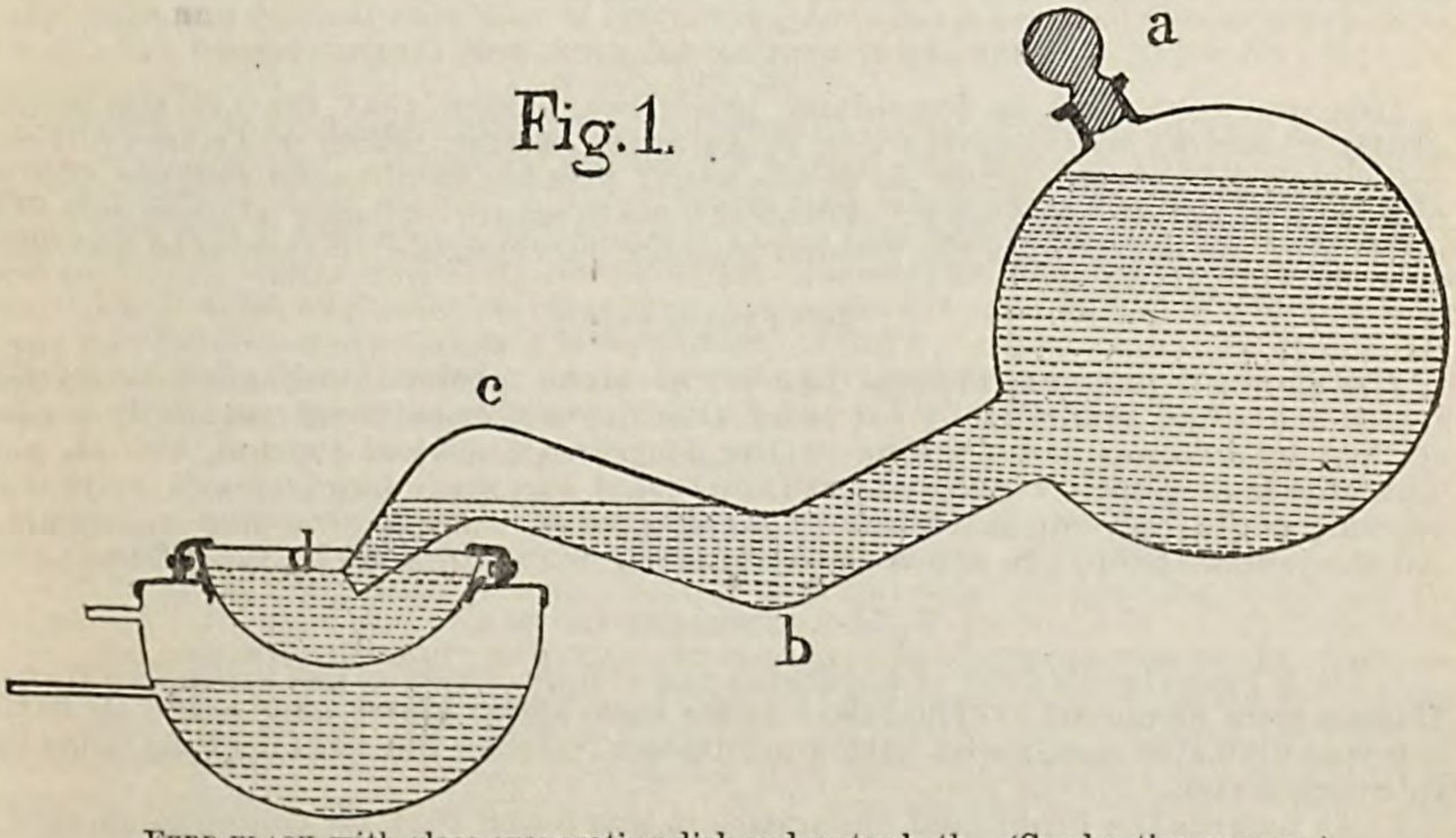
4. *Cylinders of copper gauze.*—These as at first used were found to be too short; they were lengthened to 6 inches, and were not covered with sheet copper. In the earlier analyses oxygen was sometimes found in the gases given off on combustion. Mr. Noyes is inclined to suspect that it came, not from the cupric oxide, as suggested by Frankland, but from sulphuric acid in the evaporation-residue, or cupric sulphate formed by its action.

II. Evaporation.

1. The glass dishes used were 3½ inches in diameter. A small water-bath was used, and the dish was placed in the open top so that the under side of the glass was exposed to the steam. To prevent access of steam from the bath to the water to be evaporated, an india-rubber band was placed between the edge of the ring of the water-bath (which was solid, and fitted tightly over the bath) and the glass dish, and the dish was clamped down steam-tight upon this band by four little hooks of stout brass wire, the upper (hooked) ends of which bore upon the edge of the dish, while the lower ends were attached by screw threads and nuts to the upper side of the ring cover of the water-bath. With this arrangement, and the glass shade, as recommended by Frankland, a liter of water could be evaporated in from 20 to 22 hours.

2. For the automatic feeding arrangement the flasks sent from the maker in London were found to behave very badly, the water coming down with such violence, as bubbles of air from time to time passed up through the supply tube, that the dish was almost sure to overflow. One or two also gave trouble by leakage at the ground joint between the neck and supply tube. Dr. Southworth, before leaving Baltimore, had made a feed-flask from a glass-stoppered and long-necked receiver, by bending the neck as shown in the accompanying figure, and this and others made like it were after-

Fig. 1.



Feed-flask with glass evaporating dish and water-bath. (Combustion process.)

wards used by Mr. Noyes, and found to answer perfectly well. The glass stopper at *a*, if not fitting thoroughly air-tight, was reground into its seat. The angles at *b* and *c* were made such that a good-sized air bubble could be readily retained at *c*. The mouth at *d* was ground off obliquely. The water to be evaporated was placed

at once in this receiver, the sulphurous acid and sodium acid sulphite were added, and the whole was boiled as directed by Frankland. It was found convenient to heat for ten or fifteen minutes on a capacious water-bath, then to wipe the flask dry, and apply the flame with only the protection of wire-gauze. After boiling, the flask was allowed to cool for a few minutes, and was then supported by an ordinary laboratory clamp, applied between *b* and the body of the flask, and the tube tilted until the water ran out at *d* into the glass dish previously placed ready on its water-bath, the whole being made fast in such a position that when the dish filled to *d* at the proper height a large bubble was left at *c*. The apparatus worked admirably, and is one which can be easily fitted up in any laboratory.

3. As among the water samples sent for examination, including a number of artificially polluted specimens, there was very great variation in the amount of organic matter to be dealt with, it became a matter of special importance to determine properly in advance the quantity of water which should be taken for the analysis. Instead of relying, as Frankland suggests, solely on the amount of ammonia, which was found to give a very uncertain indication, a rough test was made by acidifying 100 c. c. with sulphuric acid, heating nearly to boiling, and adding solution of potassium permanganate from a burette as long as decolorization occurred. A solution of permanganate was used of which 1 c. c. was equivalent to about 1 mgrm. of ammonium oxalate. If 100 c. c. of the water so tested decolorized less than 5 c. c. of this solution, a liter of the water was used for the analysis.

If 5 to 10 c. c. was decolorized, 500 c. c. was used.
If 10 to 15 c. c. was decolorized, 300 c. c. was used.
If 15 to 25 c. c. was decolorized, 200 c. c. was used.
If 25 to 50 c. c. was decolorized, 100 c. c. was used.
If 50 to 100 c. c. was decolorized, 50 c. c. was used,

and so on in proportion, though the indication seemed to be that in the case of waters badly contaminated with sewage or similar material, a smaller amount than that called for by the above table might be used with advantage.

4. It was found necessary to add sodium acid sulphite in every case, and it was very important that enough should be added to prevent the occurrence of free sulphuric acid in the residue. At times this occasioned very great trouble. Few of the waters examined seemed to contain a considerable proportion of carbonates serving to neutralize such acid when found.

The sulphuric acid did not seem to come chiefly from the nitrates of the waters, but rather from atmospheric oxidation, and Mr. Noyes was inclined to think that the chloride of iron added aided in inducing this change. No confidence can be placed in an analysis, unconfirmed by repetition, if sulphuric acid has been observed in the residue, even though no charring has taken place; in such a case the carbon figure is usually too low, and that for nitrogen too high, the latter from the absorption of ammonia, which was found always to occur in such cases, no matter how carefully any obvious source of ammonia was kept out of the room.

III. Preparation of the residue for combustion.

This was performed as Frankland prescribes, except that the dry residue was gently triturated with cupric oxide in an agate mortar, which was rinsed out carefully with more cupric oxide as in the usual process of ultimate organic analysis upon the relatively large scale. This was done to secure intimate mixture and closer contact of the particles of the residue with the cupric oxide; it seemed to materially improve the results.

IV. Combustion.

The Sprengel pumps sent from London were not received until after one of these instruments had been already for some time in use, resembling essentially that described by Johnson and Jenkins in the American Chemical Journal, Vol. II, p. 29. The tube immediately connected with the funnel was made large enough, so that the mercury could pass air in it, and so all danger of losing the vacuum was avoided. All the joints, except the one next the furnace, were protected by glycerine.

V. Measurement of gas.

1. Both Frankland's form of apparatus and simple, straight gas tubes like those of Bunsen were employed. The latter tubes were about 450^{mm} long and 6 or 8^{mm} in internal diameter, graduated with a millimeter scale by Bunsen's method, and carefully calibrated.

2. As regards the Frankland apparatus, it was found that for complete absorption of carbon dioxide it was necessary to pass the gas back and forth two or three times, as a little was always retained at the joint. A few analyses were lost by leakage at the stopcocks, which required to be managed with strict care.

3. In using the simple straight tubes, the gas was pumped directly into one of these; the solution of potassium pyrochromate was passed up, and agitated with the

gas by giving the tubes, partly laid down in the mercury bath, a longitudinal movement; the tube was then set upright, and after a proper time the readings were made. Caustic potash solution was next passed up, and the agitation, standing at rest, and reading repeated. Then pyrogallic acid was added, and a little oxygen passed up through an inverted funnel. Frankland's mercury trough was found to answer very conveniently for this. Careful comparative tests showed that equally good results could be obtained by either method of measurement, but on the whole Mr. Noyes preferred the plain Bunsen tubes. With the distribution adopted for the day's work, the delay necessary for the tubes to acquire the temperature of the room before each reading, was not found to cause loss of time.

4. In the calculations the barometric reading was corrected for the temperature of the mercurial column. This is not mentioned by Frankland, though probably not neglected in practice.

VI. Repetition of analyses.

Duplicate determinations were made in the case of each water, and when the results were unsatisfactory, a triplicate combustion was made.

"FREE" AND "ALBUMINOID" AMMONIA, BY THE WANKLYN PROCESS (DR. SMART).

REAGENTS.

Distilled water was specially purified by continued boiling in a long-necked flask until it gave no reaction with the Nessler test solution. A saturated solution of recently heated sodium carbonate was prepared, and ascertained to be itself free from ammonia, this being for use in aiding the expulsion of "free" ammonia, *i. e.*, ammonia existing as such or in ammoniacal salts, from the water to be examined. Wanklyn does not consider this needful in ordinary cases, but as the specimens which might be expected in the course of this research were to be unknown to the analyst as to source and general character, and might often be of unusual nature, it was thought judicious to use the the sodium carbonate for all. The solution of alkaline potassium permanganate was made with the proportions of materials, and with the precautions directed by Wanklyn, save only that instead of 1 liter of water being used for solution, one-fourth of this boiled away, and the original volume restored by addition of pure water, 1¼ liter of ammonia-free water was used at first and this was boiled down to 1 liter. The solution thus prepared gave no coloration with Nessler's test in 50 c. c., distilled off from one-half liter. The Nessler reagent was made by dissolving 35 grm. of potassium iodide and 16 grm. of mercuric chloride each in a small quantity of water, adding the mercuric solution to that of the iodide until a faint show of excess was manifested, then adding to the mixture a solution of 160 grm. of potassium hydrate in 800 c. c. of water, and making up to one liter. This solution was rendered sensitive by the addition of a few drops of a cold saturated solution of mercuric chloride, and put away to become clear in the stock bottle in which it was to be kept for use. The solution of ammonium chloride for comparison was made by dissolving 3.150 grm. of the pure and dry salt in a liter of ammonia-free water; 1 c. c. of this solution, with 99 c. c. pure water, formed the standard ammoniacal liquid for colorimetric purposes, containing in each 1 c. c. .01 mgrm. of ammonia.

The solutions having been prepared, the following blank experiments were performed to test, not only their fitness for ordinary practical use, but their absolute freedom from ammonia. Half a liter of water which had been distilled from alkaline permanganate was placed in a retort and distilled. The first measure which came over showed a faint trace of color by Nessler's test; the second remained unaltered. Ten c. c. of the sodium carbonate solution was then poured in, and 50 c. c. of water having been distilled over gave no trace of ammonia. Fifty c. c. of the alkaline permanganate solution was next added, and on distilling over another measure of 50 c. c. no indication of ammonia was obtained from it.

APPARATUS.

Wanklyn recommends that the condensing tube be wide enough to take in the neck of the retort with the aid of a little packing paper. Dr. Smart had long distrusted this mode of connection, and had been in the habit of drawing down the retort neck to fit into a short bit of india-rubber tube, the other end of which fitted over a glass tube passing through an india-rubber stopper in the upper end of the condensing tube, thus insuring against loss of steam and accompanying ammonia during the distillation. In fitting up a second condenser for the present research, Wanklyn's directions were followed, but it was found that however carefully the packing was adjusted, parallel experiments in the two condensers showed a perceptible loss in the newly mounted apparatus. The paper packing was therefore abandoned, and air-tight india-rubber connections were substituted. After this, the previously observed loss from the cause in question disappeared.

An Erlenmeyer gas lamp seemed to give a more steady flame, and to maintain more uniform boiling of the contents of the retort, than the ordinary Bunsen burner.

PROCESS.

The process followed was in accordance with Wanklyn's direction; 500 c. c. of the water under examination was distilled with the addition of a few cubic centimeters of the solution of sodium carbonate, and the distillate was collected in sucessive measures of 50 c. c. each. The free ammonia in each of these measures was estimated by comparison with the color developed by Nessler's solution in pure distilled water to which known quantities of the standard ammonium chloride solution had been added. As soon as a measure of distillate was obtained free from ammonia, or in the case of persistent evolution of ammonia it became evident that no definite end could be reached, 50 c. c. of the alkaline permanganate solution was introduced into the retort, and the distillation continued, collecting the distillate in measures of 50 c. c. as before, until a measure was obtained which showed no ammonia, or until no more could be distilled without danger to the apparatus; the ammonia in these successive measures was estimated as before. The only variation from the practice prescribed by Wanklyn, which was adopted, was one which Frankland suggests, and which Dr. Smart had found from experience to be advisable, particularly in the case of waters which might yield very different quantities of ammonia, as was to be expected in the course of this research. Instead of at once estimating the free and albuminoid ammonia, respectively, in the first measure of each which comes over, the second and in suspicious cases the third measure was waited for, Nesslerized, and the result recorded; and from the result of this experiment it became apparent whether the first measure should be similarly treated as a whole, or should be first diluted to a definite extent, so as to bring the color, with the Nessler reagent, within the limits susceptible of accurate estimation, and to avoid loss of the experiment by the precipitation which occurs in strongly charged distillates.

On adding the Nessler test to a solution containing a few hundredths of a milligramme of ammonia, a short time, usually from one to three minutes, varying with the sensitiveness of the reagent, is found to be necessary for a full development of the color. This having been attained, no perceptible change occurs for many hours afterwards. After twenty-four hours or so a slight deposit in the tube or on the surface of the liquid may show that the color therein is untrustworthy, and a comparison made with a freshly prepared tube will indicate the extent of the deterioration. But standards of color made on any one day may be used on that day for comparison with any unknown ammoniacal solution which has stood for five minutes after admixture with the Nessler test-standards. No permanently colored solutions, as of caramel, were used as color, but there was prepared each morning a series of tubes containing, respectively, .01, .03, .05, .07, and .09 mgrm. of ammonia, to which the Nessler reagent was added, and to which each measure of ammoniacal distillate was presented for comparison not less than five minutes after the Nessler solution had been added thereto, and if no perfect agreement with one of these standard tubes could be observed a new standard was prepared containing the quantity of ammonia which this first comparison has indicated as likely to be present. In all cases of freshly made color-standards five minutes at least was allowed for development.

NITRITES (DR. TANNER).

All previously proposed methods for determining nitrites are set aside by the two extraordinarily delicate reactions to which attention has been drawn by Griess, namely, that with meta-phenylene diamine,* and that with sulphanilic acid, followed by naphthylamine hydrochlorate.†

The former of these two was made use of at first, applying it according to Tiemann and Preusse's method,‡ following the instructions of Frankland's little Hand-book of Water Analysis. In clear colorless solutions it worked very well, but in samples of water already possessing a yellow color it was found impossible to satisfactorily estimate the more or less similar tint (arising from the production of triamidoazobenzole) developed by the meta-phenylene diamine in the presence of nitrites. The decolorization of such water before applying the test, by adding hydrate and carbonate of sodium, with or without alum, and filtering, as has been recommended, is troublesome and very undesirable, in view of the ease with which nitrites undergo alteration.

Early, however, in the course of the present work the later suggestion of Griess, strongly and deservedly recommended by Warington § as more advantageous, was adopted instead, and used throughout the rest of the research. This reaction, which depends on the production, in an acidified solution, of azobenzolnapthylamine sulphonic acid, with the development of a most intense and beautiful rose-red color, is much more delicate than the other, there being no doubt that, as Warington has stated, it is capable of indicating the presence of one part of nitrogen as nitrous acid in 1,000,000,000 of water, and there is the further advantage that good results can

* Berichte d. Deutsch Chem. Gesellsch., XI, 624.
† *Ibid.*, XII, 427.
‡ *Ibid.*, XI, 627.
§ Jour. Chem. Soc. (Lond.), May, 1881; 231.

be obtained even when the water has a very decided yellowish tint, the color produced by the reaction being so different. Dr. Tanner made a number of experiments in order to ascertain the most convenient form of the experiment as to details, particularly as to the strength and mode of preservation of the solutions, and adopted the following: To prepare the sulphanilic acid 30 grm. of aniline was mixed by drops with 60 grm. of fuming sulphuric acid in a porcelain dish, and the brown, sirupy liquid formed was carefully heated until it became quite dark in color, and gave off copious sulphurous fumes. After cooling, the thick semi-fluid mass was poured into half a liter of cold water, and allowed to stand for some hours. The liquid portion was then decanted off from the nearly black, undissolved crytalline mass; to the latter half a liter of hot water was added, and the mixture allowed to stand until cold, when the liquid part was again decanted off. The remaining mass was then treated with one liter of hot water and filtered; the filtrate was treated with animal charcoal to decolorize it, and allowed to stand for twenty-four hours, when it was again filtered; the filtrate was diluted to 1500 c. c. andused as the required solution. It tends to turn pink on keeping, and, this color interfering with the delicacy of the test, a small quantity of animal charcoal was kept in the small bottle containing the supply of solution for immediate use, which was filled up from time to time from the larger stock bottle. The solution of napthylamine hydrochlorate was made with 1 grm. of the salt to 100 c. c. of water. The solution required to be occasionally filtered, and not more than 100 c. c. was prepared at a time.

The water to be tested, and, for comparison, the solutions of known strength of pure potassuim nitrite (made from the silver salt) in recently prepared and tested distilled water, which had been kept in carefully closed glass bottles, were placed in color tubes of thin white glass, each of which held 100 c. c. for the same depth of liquid column. A few drops of pure hydrochloric acid having been used to acidify the contents of each tube, 2 c. c. of the sulphanilic acid solution, and then 2 c. c. of the solution of naphthylamine hydrochlorate, were added, and the whole was allowed to stand for twenty minutes, at the end of which time the color, which gradually deepens on standing, might be considered as fully developed. Each tube was covered by a bit of sheet glass, in order to prevent free access of air. Blank experiments were made from time to time to prove the purity of the distilled water and other materials used.

Perfectly accordant results were obtained by comparisons made with the same standard solution, on the one hand by means of meta-phenylene diamine, and on the other by means of sulphanilic acid and naphthylamine.

NITRATES (MR. NOYES).

Nitrates and nitrites together were determined by the mercury method (of Walter Crum*) preferred by Frankland, and in accordance with the directions of the latter. The tube used for the evolution and measurement of the nitrogen dioxide is represented in Fig. 2.

By pinching the India-rubber tube *c* which connects the graduated with the ungraduated glass cylinder *a* and *b* the escape of gas or entrance of air during agitation may be effectually prevented. The mercury in *b* was brought to one-seventh the height of the sulphuric acid above the mercury in *a*, and the measurement of the gas was made without transferring it to another vessel. No correction was made for aqueous tension on account of the moderate dilution of the sulphuric acid. Chlorine was not removed from the water residues; the experiments of Warington† and Frankland‡ seem to have established the fact that such a precaution is unnecessary. It is to be remembered that, as Warington has shown, the results are liable to be lower than the truth in cases in which much organic matter is present.

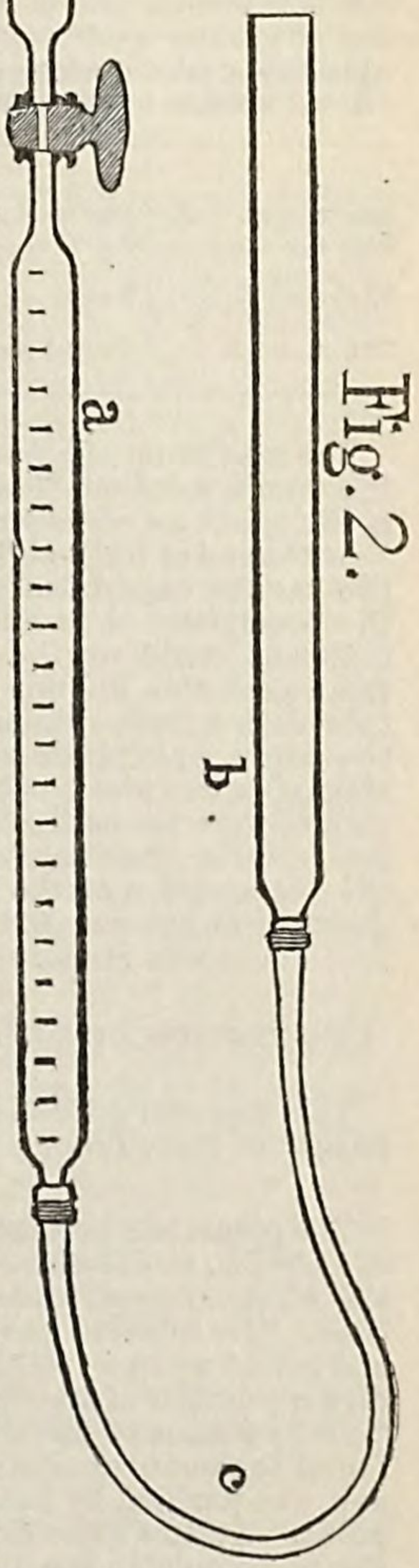


Fig. 2.

FIG. 2.—TUBE FOR NITRATE DETERMINATIONS. Graduated to $\frac{1}{5}$ c. c. Calibra ted to reach from bottom of meniscus of sulphuric acid.

* Phil. Mag. [3] 30; 426.
† Jour. Chem. Soc. (Lond.), July, 1879; 377.
‡ Water analysis, p. 87.

In order to obtain the amount of nitrogen in a water in the form of nitrates alone there was to be subtracted from the quantity of nitrogen thus found as nitrates and nitrites that due to the latter salts, as given by Dr. Tanner's experiments.

REACTION WITH TANNIN (DR. SMART).

Although but little was expected from this, some experiments were made to ascertain the practical conditions under which the test should be applied. A mixture was made of Potomac River water with 10 per cent. of urine, and this was tested with different amounts of a 10 per cent. aqueous solution of tannin, with the following results:

Quantity of polluted water.	Quantity of tannin solution.	Result.
50 c. c.....	.25 c. c.....	Faint cloudiness after sixteen hours.
50 c. c.....	1 c. c.....	Same, with slight flocculent deposit.
50 c. c.....	2 c. c.....	Cloud deposited at end of five hours, occupying about one-fiftieth of volume of liquid.
50 c. c.....	3 c. c.....	Flocculi immediately appeared; deposited at the end of two hours, occupying about one thirty-fifth of volume of liquid.
50 c. c.....	5 c. c.....	Same result.

The maximum effect seemed to be produced in these experiments by 3 to 5 c. c. of the tannin solution, the urinous water being fresh, and showing under the microscope nothing but an occasional epithelial scale.

At the end of forty-eight hours, when bacterial organisms had made their appearance, the tannin experiments were repeated, with similar results, but the separation of the precipitate was not so distinct. The liquid was cloudy and the bulk of the sediment could not be well measured, but it was obvious that 1 or 2 c. c. of the tannin solution did not produce so much precipitation as 3 or 5 c. c. The effect obtained in a fresh urinous liquid, free from microscopic organisms, shows that while the tannin precipitate may be due in some cases to mucilaginous algæ, as claimed by Hagan, it can also be obtained irrespective of them. One river water and six well waters were tested in advance of the main investigation by this method, but without result, other than the development of a little color, due to the presence of iron. In the examination of the main series of water samples, 5 c. c. of tannin solution of the above strength was added to 50 c. c. of the water, and any result occurring within four hours was noted.

CONSUMPTION OF OXYGEN BY THE TIDY PERMANGANATE PROCESS (DR. TANNER).

This was carried out with strict attention to the directions of Tidy as given in his paper* of 1878–'79.

REAGENTS.

The potassium permanganate, though well crystallized, was found to contain a trace of chlorine as chloride. It was dissolved in distilled water, silver oxide added, and the whole allowed to stand for twenty-four hours, with thorough shaking from time to time. The solution was then filtered through asbestus, found to be free from chlorine, and set away in a well-stoppered bottle as the stock from which to prepare the more dilute solution of standard strength. The original stock solution was tested at intervals by means of metallic iron and ammonio-ferrous sulphate, and the strength was found to remain unaltered. The sulphuric acid contained a faint trace of nitrous acid, and was purified by heating for some time to a temperature a little below its boiling point. At first some difficulty was encountered in obtaining distilled water in quantity so completly free from organic matter as to produce absolutely no effect upon the permanganate. The trouble was traced to some minute algæ in the large block-tin worm. The still was thoroughly cleaned out in all its parts, enough alkaline permanganate of potassium was added to the water in the body of the still to maintain a pink color, and the distillate was passed from the worm to the stone bottles through a large sand filter of several inches in depth, the siliceous sand for which had been treated with strong hydrochloric acid, well washed with water and heated to redness; 250 c. c. of the water thus prepared, on being acidified with sulphuric acid, and barely tinted with permanganate, showed no perceptible loss of color on standing in a stoppered flask for forty-eight hours. Samples of the distilled water used were thus tested from time to time, and found to be free from organic impurity.

* Jour. Chem. Soc. (Lond.), Jan., 1879; 67.

The standard solutions to be used were made as nearly as practicable of the strengths recommended by Tidy, changing the weights and measures used by him to those of the metric system, although this involved a little inconvenience in calculation from the introduction of fractional numbers; 10 c. c. of the standard solution of potassium permanganate contained .723 mgrm. of available oxygen. As a special, though probably needless, precaution, this was kept in a bottle covered by an opaque cylinder of pasteboard. The dilute sulphuric acid was made by adding 1 part by weight of the purified acid of 1.830 specific gravity to 3 parts of pure water. The potassium iodide solution contained 1 part of the salt for 10 of water. The sodium thiosulphate solution consisted of .775 grm. of the salt in 1 liter. The starch solution was made by rubbing up 4.5 grm. of starch with 300 c. c. of boiling water and filtering. The filtered liquid was boiled and allowed to stand for twenty-four hours, after which the clear portion was drawn off by a syphon. This solution changed very rapidly in hot weather, and had to be often renewed; it was found that by making the solution of double the above strength such frequent renewal was not required, while the results in use seemed to be quite the same.

PROCESS.

Two flasks of 500 c. c. capacity each were used to contain a water under examination, each sample having by it its corresponding duplicate flask of pure water for the blank experiment. Each received 250 c. c. of water, 10 c. c. of the dilute sulphuric acid, and 10 c. c. of the standard potassium permanganate solution. The four flasks were then protected from dust by loosely-fitting glass stoppers, labeled, and set aside at ordinary temperature, observing from time to time whether the red color remained, and adding, in case of its disappearance, additional measured quantities of permanganate.

At the end of one hour from the beginning of the experiment the amount of oxygen was determined which had been consumed in one of the flasks of the water under examination, and in one of the blank flasks of pure distilled water. At the end of three hours like determinations were made for the second flask of water to be examined and second blank. The determination was made by adding to the contents of the flask two drops of the solution of potassium iodide, cautiously dropping in from a burette the solution of sodium thiosulphate until the yellow color of the iodine had nearly disappeared, then adding a few drops of the clear starch solution, and, finally, continuing the addition of sodium thiosulphate until the blue color of the iodide of starch was just destroyed. To prove that the proper point had not been passed, a single drop of the permanganate solution was added, restoring the blue color by liberating a trace of iodine, or the return of the blue tint was observed after the liquid had remained exposed to the air for five minutes. It was found of some importance, in order to secure the nicest observation of the color changes at the end of the experiment, that the same quantity of starch solution should be used each time.

From the gross amount of oxygen consumed was deducted that due to the oxidation of nitrites, ferrous salts, and sulphureted hydrogen, when any of these substances were present. The nitrites were diluted and determined, as has been described above, by the sulphanilic acid and naphthylamine reaction. Iron was tested for by filling these tubes, each of 2 feet in height and 2 inches in diameter, the first with distilled water, the second with the water under examination, and the third with the same water to be examined plus a few drops of nitric acid; on adding to each a few drops of a solution of ammonium thiocyanate, a comparison of the tints presented indicated whether iron was present, and, if so, whether in the ferrous or ferric condition. Like comparative experiments, adding to the distilled water minute measured amounts of a very dilute stand and solution of ferric chloride (.08 oxygen of metallic iron to 1 c. c.) made the result quantitative. In the one or two cases in which sulphureted hydrogen was diluted, its amount was determined by similar colorimetric comparison with an extremely dilute solution of a lead salt and a standardized solution of sulphureted hydrogen.

CONSUMPTION OF OXYGEN BY THE KUBEL PERMANGANATE PROCESS (DR. SMART).

REAGENTS.

The solution of potassium permanganate used contained .1 mgrm. of available oxygen to 1 c. c., and the oxalic acid solution was made of such strength as to decompose the former, volume for volume, the strength being redetermined from time to time. The water used was purified by distillation from alkaline permanganate.

PROCESS.

To 200 c. c. of the water to be examined in a 400 c. c. flask was added 10 c. c. of dilute sulphuric acid (1:3), and such measured quantity of permanganate solution as gave a persistent red color. The liquid was then boiled for ten minutes, adding, if necessary, more permanganate in measured quantities, so as to maintain a red color. Removing the flask from the lamp, 10 c. c. of the solution of oxalic acid was added to destroy the color, or more, if the excess of permanganate required it, and the per-

manganate solution was finally dropped in from a burette until a faint pink tint was again produced. From the total quantity of permanganate used was deducted the equivalent of the oxalic acid added, and the remainder represented what had been destroyed by the oxidizable substances in the water. Of course the same corrections for nitrites, ferrous salts, and sulphureted hydrogen should be made, in case of the presence of these substances, as in connection with the Tidy process.

Dr. Smart remarks in regard to this use of permanganate at 100° C. that for ordinary waters the ten minutes' boiling suffices for the oxidation of the organic matter present, but that in much stronger solutions, which might with more propriety be called organic liquids, ten minutes is not enough, and the process does not show all the oxygen which is required. Enough, however, is shown, as he thinks, to exclude such a sample from the list of drinking waters, and hence he considers the process as one to be depended on for sanitary or technical purposes.

DISSOLVED GASES (DR. TANNER).

The gases held in solution in a sample of water were expelled and collected by means of Reichardt's very convenient arrangement of apparatus,* modified in some of the details of construction and use. The apparatus as employed is shown in Fig. 3.

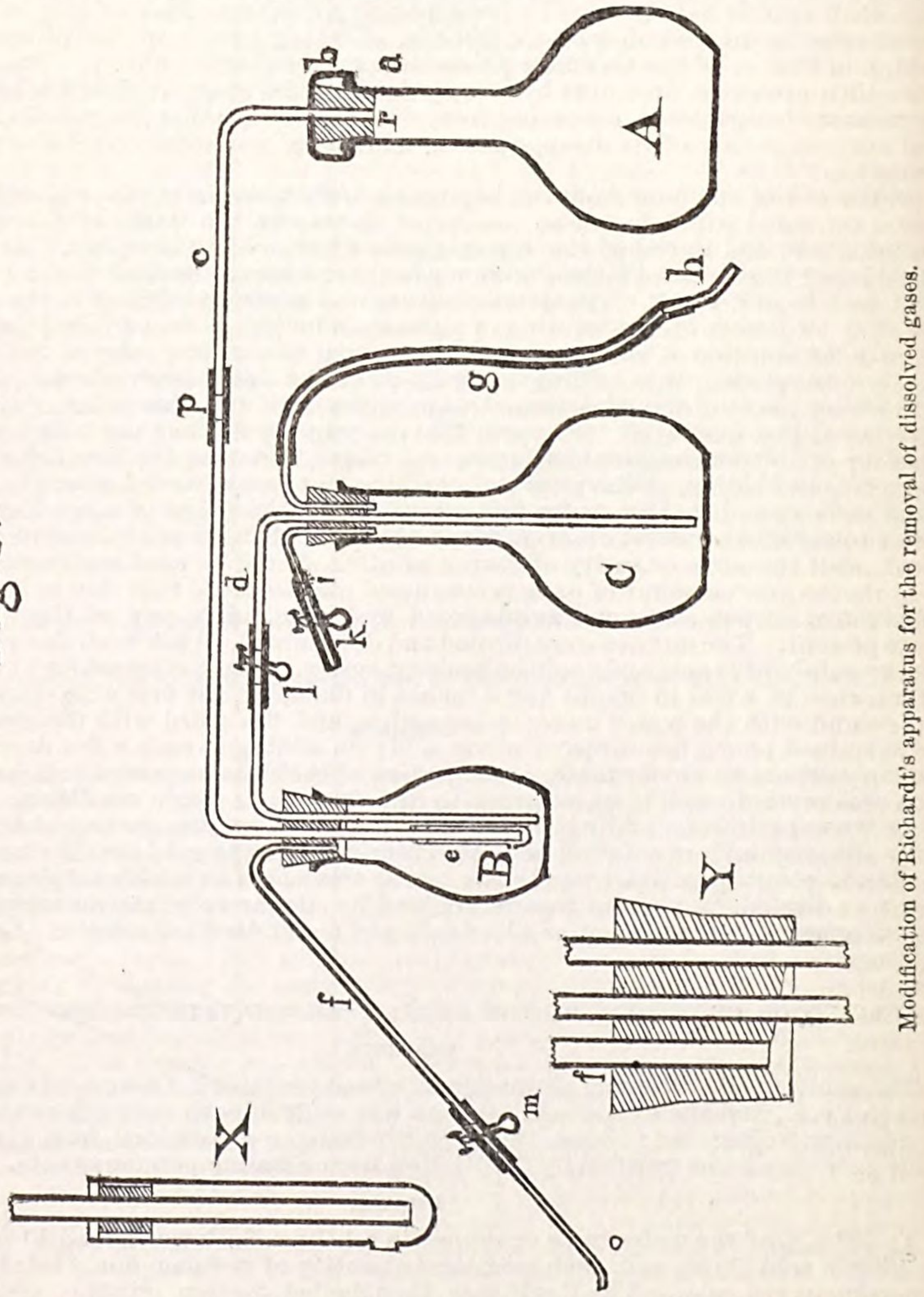


Fig. 3.

Modification of Richardt's apparatus for the removal of dissolved gases.

The three flasks A, B, and C were supported upon a single stand, not shown in the figure, A and C resting upon wire gauze at such heights that gas lamps could be

* Zeitschrift für anal. Chem., 11ter Jahrg., 271.

conveniently placed beneath them, while B was upon a little wooden shelf somewhat behind the other two. This gave considerable stability to the whole arrangement.

The flask C was first nearly filled with distilled water, which was boiled for three-quarters of an hour or an hour, so as to expel all dissolved atmospheric gases. During this boiling the pinchcock *l* was closed and the pinchcock *k* was removed from the tube *i* to *g*, *i* remaining open for the escape of steam. This tube *i*, which was not a part of the original Reichardt apparatus, enables the mouth-piece *h* to be kept cool. The flask A was now filled up to the mark *a* with the water to be examined. In the flask chiefly used the capacity up to this mark was 835 c. c. The little remaining space from *a* to the very rim of the neck of this flask was filled with cold distilled water, which had been thoroughly boiled and allowed to cool in a glass-stoppered bottle, completely filled. Removing the lamp temporarily from beneath C, the pinchcock K was transferred back from *g* to *i*, thus closing *i*, the pinchcocks *l* and *m* were opened, and by blowing with the mouth through *h g* the boiled water in C was driven over through the tube *d*, filling B andthe tube *f* to its very extremity at *o*. The pinchcock *m* was now closed, and, continuing the blowing, the boiled water also filled the tube *c* driving all air before it, and issuing from the extremity *r*, which had been permanently fitted into the India-rubber stopper intended for A, this stopper, however, not having yet been inserted in its place. As the boiled water from B was issuing from *r* the pinchcock *l* was closed, gentle pressure with the finger and thumb was applied to the India-rubber connection *p*, so as to expel the last trace of air from the orifice *r*, and relaxing the pressure on *p*, the India-rubber stopper was pressed into its place in the neck of A. A brass clamp, *b*, was fixed in position to hold this stopper firmly in its seat during the subsequent boiling. The pinchcock *l* was now opened, and the lamp being placed under A, the water under examination was boiled for a sufficient length of time* to expel all of the gases in solution, which passed over by the tube *c*, and collected in B beneath the India-rubber stopper. The boiling was continued until steam enough had passed over to bring the water in B fully up to the boiling point, and meanwhile the distilled water in C was kept gently boiling† by means of its lamp, *i* being open and *g* closed, so as prevent any reabsorption of atmospheric air. The danger of any bubbles of gas fromthe tube *e* accidentally getting into the end of *d* in B‡ was obviated by surrounding the lower end of *c* with a short test-tube, shown separately and of full size at X, this being held in place by an India-rubber stopper near the top, perforated for *c*, and notched to allow gas to pass out, while near the lower end a little hole was pierced in the side of the test-tube (turned away from *d*) to allow free entrance of water. When all the gases driven out from the water in A had collected beneath the stopper in B, the water in this latter vessel and in C being at 100° C., the lamp was removed from A, which refilled itself with water from B, which in turn was kept replenished from C, the lamp beneath which was also taken away; the pinchcock *k* was replaced on I, and the pinchcock *m* was opened, blowing cautiously into C through *h g*. At first the little water in the almost capillary tube *f* was expelled, but at the moment at which the last drop was about to issue, the extremity (*o*) of this tube was introduced into the mouth of a gas tube, filled with mer-

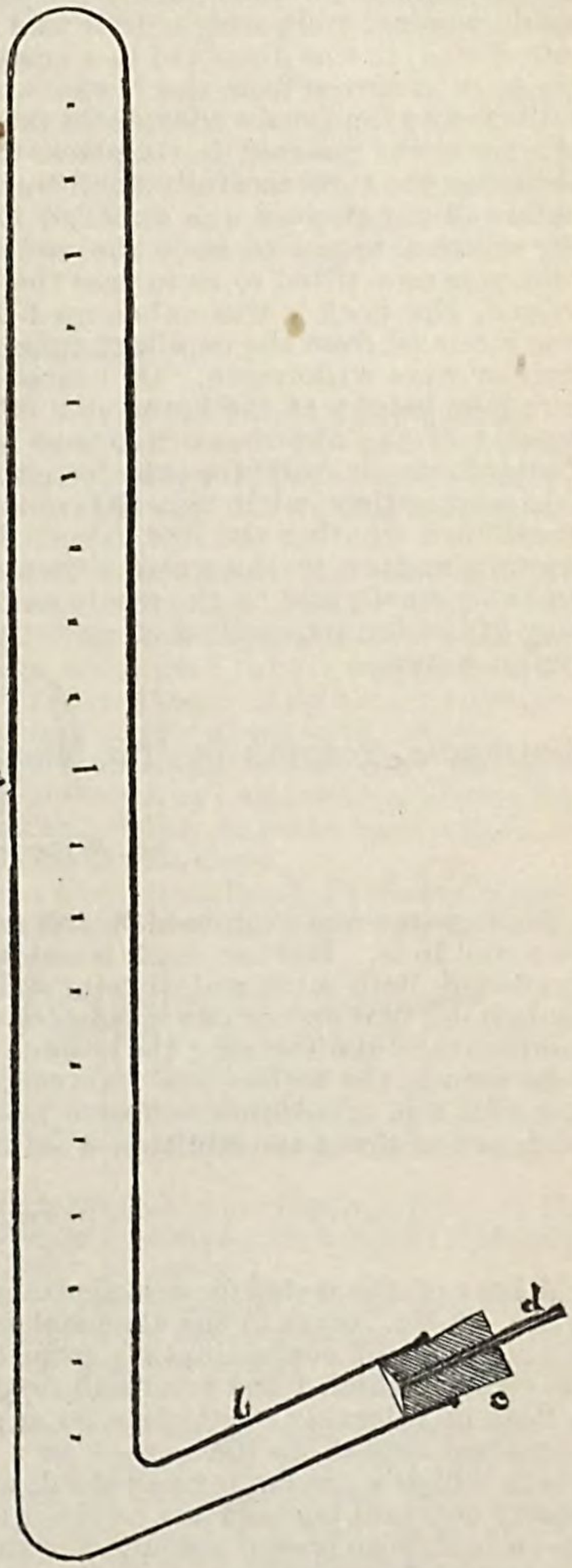


FIG. 4.—Gas tube used for collection of dissolved gases expelled from water. Capacity 50 c. c., graduated to one-fifth c. c.

* Generally about an hour.
† As recommended by König and Kranch Zeitschrift für anal. Chem., 19ter Jahrg., 260.
‡ Suggested by König and Kranch as a possible or probable source of error, *loc. cit.*

cury, and standing over a portable mercurial trough. On continuing to blow air into C, the gases which had collected in B were driven out through *f* into the gas tube, the clean removal of the last trace of gas being facilitated by the conical hollowing out of the lower end of the stopper of B, as is shown of full size in Y. By blowing gently, and watching the water which follows the gas through *f*, it is easy to close the pinch-cock *m* at exactly the right moment, and thus prevent water entering the gas tube.

The mixture of gases collected was anlyzed by Bunsen's methods, using as the gas tube a Cooper's receiver, with modified form of stopper, which greatly facilitated the introduction of the reagents. Fig. 4 shows the gas tube and stopper of full size.

The carbon dioxide was absorbed by caustic potash, and the oxygen by an addition thereto of pyrogallol, noting as regards the proportions used for oxygen absorption the results of the experiments of Weyl and Zeitler,* and also of some experiments made specially for the present purpose by Dr. Tanner himself. The charges of the solid reagents were weighed off and kept ready for use. When a charge was to be introduced, it was dissolved in a small measured volume of water, and, mercury having been removed from the neck *b* at the lower end of the gas tube *a* so as to leave rather more than space enough for the volume of solution, the perforated India-rubber stopper *c* was inserted in its place, the gas tube being held in an inclined position. Bringing the tube carefully back to the vertical, the little air beneath the conically hollowed-out stopper was expelled through the bit of capillary glass tube *d*, and as the solution began to issue the end of this tube was closed by the finger. The gas tube was now tilted so as to pass the solution up into contact with the gas to be absolved, the neck *c* was submerged beneath the mercury in the trough, the finger was removed from the capillary tube, and finally this tube itself and the India-rubber stopper were withdrawn. Of course all the proper connections for temperature, pressure (the height of the barometer column reduced to 0° C.), &c., were made. The density of the absorbent solutions was determined and allowed for. Analyses of atmospheric air made for practice gave excellent results.

In connection with this determination of dissolved gases, it may obviously be questioned whether the free oxygen does not during the boiling act to some extent on organic matter in the water under examination, but any error from this source is probably small, and on the whole can hardly be taken to outweigh the superior accuracy of the Bunsen method of gas analysis over other modes of determining free oxygen in water.

Biological Portion of the Work (Professor martin, Dr. Sternberg, Dr. Hartwell).

MICROSCOPICAL EXAMINATION.

Each water was examined on the day it was received, to see if any organisms could be found in it. Having been let stand for a few hours the deposit, if any, was first examined, both with and without staining fluid (aniline violet). The water was then shaken up, and one or two specimens examined after evaporation to dryness at a low temperature and staining the residue with aniline violet.

So soon as the water was received, 200 c. c. was set aside after the addition of 1 c. c. of a 1 p. c. solution of osmic acid. Next day the deposit was examined, both with and without the addition of aniline violet.

CULTURE EXPERIMENTS.

A liter of the water for examination was evaporated at a low temperature to about 5 c. c. by Mr. Noyes in the chemical laboratory. The evaporation was accomplished without risk of contamination from the air, and within a moderate time, by an arrangement which I had tried and found to answer well, at the University of Virginia. A flask of tolerably stout glass, so as not to be crushed by atmospheric pressure, was immersed almost up to the neck in a large zinc trough serving as a water-bath, beneath which a gas lamp was placed, and the flame so regulated as to maintain a very nearly constant temperature of 35 C.† in the bath. A glass tube of about three-eighths of an inch bore passed through the stopper, which was of considerably larger diameter at top than bottom in order to prevent its being forced into the flask by external pressure, and the tube was bent down immediately above the stopper at an angle of about 70°. This inclined portion of the glass tube, a few inches long, was attached by a thick India-rubber connection to the upper end of a coil of block-tin tubing, of about the same bore, and of about 20 feet in length. The coil lay in a wooden worm-

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* Liebig's Annalen, 205, 255.

† Mr. Noyes informs me that with him it ranged from 33° to 38°; in a very few instances it may have reached 40°.

tub, through which passed a stream of cooling water at about 20°–24° C.* The lower end of the tin tube was connected with the exhaust of a "jet-pump" of the excellent pattern devised by Professor Richards, of the Massachusetts Institute of Technology, which was capable of maintaining a vacuum of 26 or 27 inches of mercury. The water being placed in the flask was rapidly evaporated under the diminished pressure, so that on an average a liter† could be brought down to a few cubic centimeters within eighteen or twenty hours, without the temperature having varied more than two or three degrees from 35° C. In using this apparatus when first set up, I was much annoyed by the sudden changes in the stream of water through the pump, due to persons abruptly turning water on or off at other stop-cocks on the same system of water-pipes, producing frequent variations of pressure in the flask, and every now and then spoiling its contents by water forced in from the pipes. This difficulty was completely overcome by placing between the jet-pump and tin tube a little valve opening towards the pump, made of a short brass cylinder with a hole through its axis, covered at one end by a strip of India-rubber tied across it.

Part of the concentrated residne of the water from this evaporation was filtered as soon as it reached the biological laboratory, and inoculated with a tiny drop of a stale hay infusion, containing a large variety of bacterial organisms.‡ Part of the inoculated liquid was placed in a hermetically sealed flask, and put in a warm chamber at 40° C. The rest was put in a refrigerator. Next day both specimens were examined microscopically with and without aniline violet, and compared as to the number of bacterial organisms in them.

PATHOLOGICAL EXPERIMENTS.

Of the remaining portion of the concentrated residue of each water, 45 minims,§ or a little over 2.5 c. c., was injected beneath the skin of a rabbit. The point of injection varied somewhat, being generally in one part or another of the anterior abdominal wall, sometimes in the neck. During the latter part of the work Dr. Hartwell usually selected the groin.

The animal was tied down, and at intervals of an hour three observations of his temperature *in ano* were taken before the injection. After the injection five observations (usually) were taken at hourly intervals. The next day the rabbit's temperature was also taken each hour. In each case an uninjected rabbit was tied up for comparison, and his temperature was taken at the same times. Any obvious disturbances of the animal's condition in other respects than temperature were noticed.

In the greater number of cases in which the rabbits experimented on died, *post-mortem* examinations were made, and any abnormal appearances observed were recorded. In some instances during very hot weather it was impossible to make such examinations before commencing decomposition rendered them valueless.

Since the laboratory work of this research has been completed, Professor Martin has kindly furnished me with his views as to these pathological experiments in the following letter:

BIOLOGICAL LABORATORY, JOHNS HOPKINS UNIVERSITY,
Baltimore, Md., November 5, 1881.

DEAR PROFESSOR MALLET: In using the temperature charts of the rabbits injected with various drinking waters, in the series of experiments carried on for the National Board of Health in my laboratory, there are several points which should be borne in mind.

1. The normal temperature of a rabbit varies considerably (as much as 3° or 4° F.) with season and external temperature. Thermometer readings which would undoubtedly indicate fever in April would not do so in July or August.‖

This difficulty we have endeavored to avoid, or at least diminish, by having always one or more comparison rabbits, whose temperatures were taken simultaneously with those of the experimental animals, as also, after the first few weeks, by always noting the temperature of the room in which the animals lay.

2. Apart from seasonal and slight diurnal variations, the normal temperature of different rabbits varies, often as much as 2° F. To justify the deduction that fever is present, we must therefore not merely compare the temperatures of the injected and uninjected animals, but note in the case of the former whether any considerable elevation of its individual temperature curve took place after the injection, and also whether this rise, when present in the injected animal, was absent from the curve of the uninjected. In the earlier part of the season temperatures rose often two or more

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* By using ice water still more rapid evaporation may be obtained.

† Four flasks were used, each of 500 c. c. capacity; 250 c. c. of the water was placed in each and all were immersed in the same bath, and connected with the same condenser and air-pump.

‡ Of course the germs of some organisms may have been received also from the air.

§ In the case of two or three of the waters first examined 30 minims was the quantity used.

‖ The oppressively hot weather of a portion of July and August undoubtedly affected some of the rabbits greatly, and was probably an important factor in causing the death of some.—J. W. M.

degrees as a cool morning gave place to a warm afternoon. If, therefore, a marked afternoon rise of temperature is noted in the injected animal, the temperature curve of the uninjected should be carefully examined to make sure that it has no indication of a similar rise before a belief that the injection caused fever would be justified.

We have endeavored to minimize errors from this cause, not only by always having a comparison rabbit in all cases, but also, as far as individual temperature peculiarities are concerned, by taking the temperature of the experimental animal on one or two days before it was used for injection.*

3. There is much dispute as to what the normal temperature of a rabbit is. If the animal be caught and held by the hand, its rectal temperature, if taken at once, is two or more degrees higher than if it be held quiet or hypnotized for an hour before the temperature is taken.

Similarly, when an animal is first tied down, its temperature is considerably higher than it is an hour or two later.

Researches by various physiologists have shown that in fixed animals the temperature chart till death shows three tolerably well-marked stages:

(*a*) *The stage of first temperature fall*, in which the temperature falls 2°–4° F. in two hours or less.

(*b*) *A stage of approximately constant temperature* succeeding the stage (*a*) and lasting several hours; in this stage variations from hour to hour of not more than about 1° F. occur, and during its course the general tendency is to a fall of temperature.

(*c*) *The stage of final temperature fall*, in which hour after hour the temperature diminishes with considerable rapidity, until it sinks to about 77° F., when death occurs.

The duration of the second stage is longer, and the onset of the final one later, the less tightly the animal is bound down, and especially when its head is left free. The second stage, when care is taken, lasts in most cases at least twenty-four hours.

It is clear that temperature readings should be taken during the second period; any distinct *rise* of temperature in it means fever. A distinct and sudden fall of temperature in it would not necessarily indicate a pathological result of a previous injection, as it might only be an unusually early occurrence of the third stage.

All our temperature records were made in the first stage and the first seven or eight hours of the second. The injection took place about the end of stage (*a*), and a considerable rise of temperature in stage (*b*), I think, undoubtedly means true febrile disturbance, subject, of course, to the precautions indicated in section 2.

Our rabbits were laid on the back in wooden troughs, each leg fixed by cord, and the head entirely free. Experiments made during twenty-four consecutive hours have shown that under these conditions the second stage lasts in most cases at least twenty-four hours.

I may here note my belief that the temperature of this second stage is the real normal temperature of the animal. The high initial temperature of the first stage I believe simply to be due to vaso-motor dilation of the rectal vessels, owing to the fright of the animal, and comparable to the flushing of the ear, accompanied with a rise of temperature, which may be seen in any scared rabbit. Its extreme variability in different rabbits and in the same rabbit on different days, and its very rapid fall in the first stage seem to point to this explanation. Most physiologists, however, believe otherwise, and I intend to take an early opportunity of more fully discussing the question.

The main point which concerns us here is that in the second stage we have a period, lasting several hours, of fairly constant temperature, in which any febrile rise can readily be noted; but a rise of 1° or 1°.5 F. may mean nothing, as normal variations to that extent occur.

4. It is a matter of considerable importance how far the thermometer be introduced into the gut; the latter may be divided into a part anterior to the pelvis, a part within the pelvis, and a final short tract near the anus and behind the pelvis. The last part is the coolest, and more so the nearer the anus; the first considerably the warmest, and warmer the higher the thermometer bulb is passed into the abdomen.

Throughout the pelvic region the temperature does not vary; at any given time it is the same whether the thermometer be higher or lower in the gut. We have, then, therefore, a region of five or six centimeters in length in which temperatures should always be taken. In all the observations made for the National Board the thermometer bulb was placed in this intra-pelvic portion of the rectum.

5. Rabbits are by no means healthy animals. During hot weather especially those kept for laboratory use show a considerable rate of mortality. Not unfrequently the uninjected rabbits used for comparison died, and in most of these cases death was preceded by fever. It is therefore not justifiable to conclude from one case of fever or death following injection that the injection caused the diseased condition.

We have always made two examinations, and but little weight should in most cases

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* Dr. Hartwell informs me that during a considerable portion of the summer it was impracticable to carry out this portion of the instructions which I left for the guidance of Dr. Sternberg; rabbits were too scarce.

be given to experiments in which only one injection of the two caused pathological phenomena

I say in *most* cases, because for the first month or six weeks the method adopted was to inject one rabbit one day, and if symptoms resulted, repeat with the residue of the concentrated water on the next day. While this method was followed there were several cases in which an injection (on, say Tuesday) was followed by marked disturbance, but a repetition (on Wednesday or Thursday) on another rabbit was not. I soon noticed, however, that in the interval (especially if the weather was hot) the concentrated water had frequently undergone marked change, putrefaction or otherwise; and have no doubt that in some cases pathogenic material present in it, when first injected, had been destroyed before the second injection.

Since early in June two rabbits have always been injected with the same water on the same day. If under these conditions only one showed fever I think not much importance should be given to it.

Also, when, as has sometimes happened, a concentrated water could not be injected on the day it was received, the results of a later injection should be viewed with some suspicion, whether positive or negative. In hot weather the injected water had probably changed considerably before injection.

6. As the whole question of the validity of such injection experiments, and of their availability in determining the merits or demerits of a water, is, I imagine, one chief end of this series of experiments, it may be well that I should, before knowing the source of any of the waters used, or the results of their chemical examination, state briefly what waters, judging from a rapid look over the temperature and death records, seem to me to be dangerous, and what subject to considerable suspicion.

The dangerous waters are, so judged, ———*

The suspicious waters are ———*

No doubt if the work were to be done all over again we could do it much better. We have had, step by step, to learn our methods as we went, and with the experience already gained could, I am sure, carry out a much more complete and satisfactory set of examinations in future. The present series is perhaps rather to be regarded as a preliminary attempt (and the first ever made) to plan and carry out an extensive series of biological examinations of drinking waters, and an effort to see what might be hoped from such examinations when the methods were perfected, than as in itself a perfectly satisfactory biological examination of all the waters investigated in its course.

I remain yours, very truly,

H. NEWELL MARTIN.

Professor MALLET, F. R. S.,
The University of Virginia.

P. S.—I may add that we have in tabular form a temperature history of every rabbit observed during the whole series of experiments. In many cases a rabbit was used six or seven times for comparison or injection with waters which proved harmless before it finally succumbed. In most cases of special interest, therefore, I could make out a previous temperature history of the animal, should you desire it.

In the preceding pages "uninjected" rabbit includes animals injected, for comparison, with distilled water only, as well as those not injected at all. "Injected" rabbit means always the animal injected with one of the waters to be investigated.

Dr. Hartwell has also, from time to time, and especially at the end of the work, furnished me with some of his impressions as to the pathological experiments.

He was inclined to think that the rabbits might with advantage be fixed in a more nearly normal position, such as that suggested by Hõgyes,† leaving the animal free to feed. He also thought that the temperature observations might with advantage be extended over longer periods than portions of two days, suggesting that in the case of waters likely to spread typhoid fever it is hardly likely that the full effect would appear for many days. But if the advantage of the somewhat hypnotized condition of the rabbits and the comparative stability of temperature during the second stage of observation noticed by Professor Martin were abandoned, it seems likely that far more extensive and laborious investigation of the rabbit's normal temperature as influenced by eating, drinking, moving about, if the animal were free, or long-continued confinement, if he were tied, would have first to be undertaken before any conclusions could be safely drawn from observations made under such new and more complex conditions. Dr. Hartwell would prefer to use fresh animals only in the injection experiments, though the risk seems small of the effect of any one experiment being delayed so long as the interval which always elapsed before the same rabbit was used a second time. He was of opinion, finally, that a careful and searching *post mortem* examination should be made of every injected rabbit that dies, including microscop-

* These will be found reported in the general table of results.
† Archiv. für exper. Pathol. u. Pharm., 13, XIII; Ib., 5.

ical as well as naked-eye observations of the various viscera. The examination of the fluids of the body seemed to him insufficient in searching for bacteria, but it was impossible for one person to attend to all the rest of the work and prepare also sections of the viscera in which bacterial organisms might be found as the result of an injection. Much fuller information seems to be needed on the normal and pathological histology of the rabbit if this line of investigation should be followed up.

FORMS IN WHICH RESULTS ARE REPORTED.

It was decided that the quantitative results of all the chemical determinations should be expressed in *parts per million*. This use of decimal notation is clearly to be preferred to such a statement as grains per gallon, and in comparison with a record of parts per hundred thousand is rather more convenient and suggestive of absolute values, since it practically means milligrams per liter. This statement is used in this sense only, the water being measured, not weighed.

As it has been usual with those applying the Wanklyn process to state directly the amounts of ammonia, free and albuminoid, obtained, such statements are given, but the corresponding amounts of nitrogen are calculated, as that of the free ammonia had to be subtracted from its sum with the organic nitrogen by the Frankland process in order to obtain the latter, and the same value is needed in calculating, according to Frankland's process, the total inorganic nitrogen.

The nitrites and nitrates are expressed by the amount of nitrogen they represent, these figures also being used in calculating the total inorganic nitrogen.

The dissolved gases are stated both by volume, as cubic centimeters per liter, and by weight as parts per million or milligrams per liter.

CLASSIFIED AND DESCRIPTIVE LIST OF THE WATERS EXAMINED.

The following list gives, in somewhat fuller detail than will be found in the main table of results, the chief facts as to the history of each water:

CLASS I.—*Natural waters, believed from actual use to be of good, wholesome character.*

No. 1. *Rain-water*—Rain-water, collected and stored in an iron tank, New Orleans, La. Rain-water is largely used in that city, but is more commonly collected in wooden (cypress) cisterns.

No. 2. *Artesian well-water*—Water from the artesian well which supplies the water works of Charleston, S. C. The well is 1,974 feet deep, entering the Eocene beds at 64 feet from the surface, and the cretaceous at 441 feet, in which latter it continues to the bottom of the boring. It is tubed for the entire depth with wrought-iron tubing. The free flow, when the mouth of the well is open, is said to be 250 gallons per minute. The water, which has the temperature 99°.5 F. (37°.5 C.) as it leaves the well, is carried by a closed iron pipe to a reservoir, whence it passes, by the mains and service pipes, to consumers. The sample examined was furnished me by Dr. Allard Memminger, of Charleston, and was taken by him from the pipe connecting the well with the reservoir, just before reaching the latter. Dr. Tanner having found nitrites in this sample, caused it to assume special interest, in view of the great depth of the well and the immense beds of fossil remains underlying the district in which Charleston is situated—beds which have supplied such large quantities of phosphates to commerce within the last few years. This interest was increased by my receiving soon afterwards from Dr. H. B. Horlbeck, secretary of the board of health of Charleston—who knew nothing of the examination, or even of the water having been sent to me—a letter in which he stated that his attention had been requested by a physician of the city to several cases of intestinal disturbance, some of them attended with marked choleraic symptoms, believed to have been caused by the use of the artesian well-water. Dr. Horlbeck stated that there had been six deaths during the previous week from typhoid fever, a very unusual occurrence, and that diarrhœal affections had been common for two months, but said that he was not prepared to charge the water in question with any connection with these facts. He wished an examination made of the water, offering to send samples. I was very glad to have an opportunity of repeating the examination for nitrites, and consented at once, requesting further evidence as to the effects of the water on consumers. I received the following additional samples from Dr. Horlbeck:

No 3. Second sample of same artesian well water, taken from same pipe as No. 2, before entering reservoir.

No. 4. Third sample of same artesian well water, taken from a regular city hydrant, after passage through the reservoir and mains.

The reservoir contains 3,300,000 gallons; excavation for it extends 12 feet; the bot-

tom is a shell formation upon hard stiff mud; upon this 12 inches of puddled clay; then bricks laid on gravel and filled with cement. The walls consist of 2 feet of puddled clay, with a facing of two layers of brick laid edgewise; the east wall has settled 2 inches, leaving small cracks; just opposite these cracks the ground is much lower, so that the reservoir wall is there supported by embankment. Dr. Horlbeck stated, in sending these samples, that the physician who had suggested a connection between cases of illness under his care and the use of this water, would write to me on the subject; that he (Dr. Horlbeck) has asked several other physicians as to any injurious effects from the use of the water, but had failed to elicit any facts in connection therewith; and that typhoid fever had been prevalent to a limited extent in parts of the city where the artesian well water is not used. The gentleman who believed that he had observed evidence of ill effects from the use of the water, and who, not caring to engage in any controversy on the matter, requested that his name should not be used, kindly furnished me with the facts as to several cases in his own practice; some of violent choleraic diarrhœa, one case ending in death, which seemed, from the patient's own statements and the surrounding circumstances, connected with the use of this water; others of slighter intestinal disturbance, both diarrhœal and dysenteric, commencing, as it seemed, with the use of this water, and ceasing with its disuse. He also mentioned the statement to him by many persons not patients that the artesian well water did not agree with them; adding, however, that a number of other persons had told him that they drank the water with impunity after it had been iced. This gentleman's opinion was that the artesian well water is contaminated in the reservoir through the bottom, presumed not to be water-tight, by organic matter from privy vaults, &c., soaking through the sandy soil beneath the city.

The question of the wholesomeness or unwholesomeness of this water, manifestly of local and practical importance, is alluded to here as bearing on the position to be assigned to the water in classification for the purpose of this report. In view of the general belief that water from such a depth is remarkably free from organic pollution, a belief which led to my originally sending for a sample, as representing in this sense typically pure water, it is placed in Class I; *possibly* the above evidence ought to relegate it to Class III. As far as any contamination in the reservoir is concerned, the first and second samples (Nos. 2 and 3 of this list) are free from suspicion.

It will be seen from the general table of results that the second sample of this water gave no evidence of the presence of nitrites, while the third only afforded a trace; still a fourth sample from a hydrant in King street, obtained yet later in the autumn, was examined for nitrites only, but none could be found. I am unable to explain these different results. The examination of the first sample was by my request repeated more than once by Dr. Tanner, who did not know what he was dealing with, rinsing out all the tubes most carefully, and applying three different methods, and the results were unmistakable and perfectly concordant. A searching investigation as to the filling, keeping, and handling of the bottles of water failed to indicate any possible source of accidental introduction of nitrites in the laboratory. The results in the case of the second and third samples were as clearly negative. On account of the great depth of this well, and its free flow, the well-ascertained occurrence of nitrites in the water would be very interesting; and hence it is to be desired that it be examined from time to time by the delicate naphthylamine test. The point is still undecided.

PURE SPRING WATER, DIRECTLY FROM SPRING.

No. 5. Water taken directly from the principal spring feeding the reservoir from which the University of Virginia is supplied with water. This spring rises from a coarse sandstone or grit on the side of the so-called "Observatory Mountain," a hill near the university, with no buildings, cultivated ground, or other apparent source of contamination above its own level, or within a very considerable distance even below. The hill is simply covered with natural forest growth of no great size. At the time the sample was taken the spring opening was above the level of water in the reservoir.

SPRING WATER STORED IN A RESERVOIR.

No. 6. Water taken in April from one of the hydrants in the chemical laboratory of the University of Virginia. This was the same water as No. 5, save that it had been collected in a reservoir formed by a brick dam with cemented face, thrown across a small ravine, and had been transmitted to the university, a distance of about a mile, through iron pipes. During its storage in the open reservoir the water had been exposed to mixture with surface drainage from the woodland face of the hill, and to leaves, &c., washed in or carried by the wind.

No. 7. Same as No. 6; the sample drawn a day or two later.

No. 8. Another sample of same reservoir water, taken in July, just after a rather heavy rain, following a drought which had lasted several weeks.

WELL WATER OF APPARENTLY GOOD CHARACTER FROM A RATHER DEEP WELL.

No. 9. Water from a well 48 feet 6 inches deep, attached to the dwelling of the janitor of the University of Virginia. The well passes through heavy red clay; the water is not exposed to any apparent source of pollution, and is raised to the surface by a wooden pump.

No. 10. Another sample, taken a month later, from the same well.

SURFACE WATER FROM STREAMS OF COMPARATIVELY SMALL SIZE AND SHORT COURSE.

No. 11. Cochituate water, forming a part of the regular supply of Boston, Mass. The sample was taken from a drinking fountain on the Boston Common, where there is a constant flow.

No. 12. Croton water, from the regular supply of New York City. The sample was taken from a hydrant in the lower part of the city.

No. 13. Regular water supply of Baltimore, Md., prior to October, 1881. The sample was taken from a hydrant at the Johns Hopkins University, before the introduction of the new supply from the Gunpowder River, and came therefore from the source previously depended on, namely, Jones's Falls and Lake Roland.

SURFACE WATER FROM RIVERS OF LARGER SIZE AND GREATER LENGTH.

No. 14. Regular water supply of Philadelphia, Pa., pumped from the Schuylkill River at Fairmount. The sample was taken from a hydrant on Chestnut street.

No. 15. Regular water supply of Washington, D. C., derived from the Potomac River. The sample was drawn from a hydrant in the northwest part of the city.

No. 16. Regular water supply of Richmond, Va., pumped into reservoir from the James River. Sample taken from a hydrant in the yard of a private house.

WATER FROM NEAR THE MOUTH OF A GREAT RIVER.

No. 17. Mississippi River water, as supplied to New Orleans by the city water-works. The sample was taken from the upper reservoir.

No. 18. Mississippi River water from New Orleans, as forced on week-days directly from the river into the mains (instead of the reservoir). Sample taken from a regular city hydrant.

WATER FROM ONE OF THE GREAT LAKES.

No. 19. Water of Lake Michigan, forming the regular supply of Chicago, Ill. The water is brought by a tunnel from a point two miles from the shore. Sample drawn from a regular city hydrant.

CLASS II.—*Natural waters which there seems to be fair ground for believing have actually caused disease on the part of those drinking them.*

No. 20. Water from the public spring of Harrisonburg, Va. This water was offered for examination by H. V. Strayer, esq., mayor of Harrisonburg, on the ground that there had "been considerable sickness and several deaths in the community, supposed to be the result of the use of water from the public spring." On asking for medical testimony on the subject, I received a statement, signed by Drs. S. H. Moffett and W. D. Hopkins, to the effect that the water of the town spring in Harrisonburg is liable after a rainfall to receive a large proportion of surface water, which is apparently very impure, and that these gentlemen "think it may be truthfully asserted that the use of this water has in some cases produced typhoid fever, the patients living near the spring and using it constantly."

No. 21. Water from "driven wells" in Titusville, Pa. This water was sent me by Thos. L. Hobart, Esq., secretary of the board of health of Titusville, with the statement that it came from driven wells on Short street in that city; that this locality has not been reached by the water-works or sewers, but depends on surface drainage into Oil Creek; that the wells in question (sections of wrought-iron tubing) penetrate a stratum of gravel which underlies the city from north (the highest portion) to south about 16 feet from the surface; that this gravel bed receives the filtration from many cesspools and other sources of impurity before reaching Short street; that during the previous ten months there had been thirteen cases of typhoid fever with five deaths, eight cases and four deaths occurring in this locality within the last two months of the time; that of the thirteen cases all but two occurred where the well water was used; that the general sanitary condition of the locality was fair, and that physicians attributed these cases of typhoid fever mostly to the use of water from the driven wells.

No. 22. Water from a shallow well at Mariner's Harbor, Staten Island, N. Y. This was sent me by Dr. E. D. Coonley, of the place in question. He stated that on the afternoon of Wednesday, March 23, he was summoned to see a girl, aged six years, thought to be dying. He arrived at the house at about 5 h. 30 m., and found that the girl had died between 3 and 4 o'clock. She had complained the day before of headache; had had a chill, and vomited; after dinner on the following day had a convulsion, and died at the time stated. No autopsy. On the following Sunday, at 11 p. m., he was sent for to see another child of the same family, a boy of eight years old. He found symptons of malaria; the boy had had a chill, followed by some febrile excitement. Calomel and quinine were prescribed, and a second call was made on the afternoon of the next day. The child had had another chill, and was now delirious, with spells of restlessness. In a few moments a convulsion seized the patient, which lasted about twenty minutes, and ended in death. One pupil was contracted, and respiration ceased some time before the heart stopped beating. As the remaining three children were now showing the same symptoms of malaria, Dr. Coonley ordered the family to move into another house, about 30 rods distant, situated upon higher ground. The following were the attendant conditions: The ground upon which the house stands is very low, so that occasionally the tide surrounds the latter. The well was only about 6 feet deep, and about a month before the death of the first child it was completely filled by a very high tide. The well was then baled out, and when the water came in a green scum was noticed on the surface of it. The dooryard was kept in a filthy condition. This was the only water used from the time of bailing out the well until the second child died, and the mother stated that these two children drank a good deal of the water. The remaining children promptly began to recover under the same treatment that was commenced with the second case, and at the time of Dr. Coonley's letter (April 14) had been fully restored to health. He expressed his belief that the cases observed were attributable to the use of this well water.

No. 23. Public water supply of Burlington, Vt., sent to me by Dr. Geo. M. Ockford, of that city. This water is said by Dr. Ockford to be suspected by him and other medical men of Burlington on the ground of "the frequent and almost constant presence at all seasons of the year of diarrhœal affections in persons using the water." The water is obtained by pumping from Lake Champlain, into which a large proportion (probably seven-eighths) of the sewage of the city finds its way. The system of sewers is incomplete. A ravine intended for the main sewer, and receiving a number of lateral sewers, discharges into the lake about three-quarters of a mile south of the pump-works. Another principal sewer empties about half a mile from the pumps. A certain amount of surface drainage from a district practically without sewers finds its way to the shore immediately above and below the pumps. Lake View Cemetery is on a side hill inclining toward the lake about three-quarters of a mile north of the pumps.

The Winooski River, which receives a large amount of back drainage, discharges into the lake about 3 miles north of the water-works. A breakwater running parallel to the shore southwards from the water-works may aid in setting up currents along the water front, where wharves extend, carrying sewage from the shipping and from the largest sewers, sometimes towards, sometimes away from, the water-works. Dr. Ockford says, in a letter accompanying the sample of water: "I have conferred with several other physicians (among them the health officer), and all agree with me in thinking there is a reasonable ground for suspecting said water, some even positively affirming its pollution." In a later letter he says: "I have endeavored to ascertain the views of the medical profession regarding the use of the water. A difference of opinion prevails, some asserting positive injury from its use, while others have noticed it as aggravating existing disorders, and others had no opinion on the subject."

The water supply comes from near the shore (within a few feet), and is pumped, day and night, in winter, directly into the mains for distribution, the reservoir only receiving any surplus. In summer the pumps are worked at night only, and deliver into the reservoir. The sample sent me was taken from a hydrant during the time of the former of these arrangements.

No. 24. Well water from Fairfax Court-House, Va. This water came from an uncovered and loosely-walled well, about 35 feet deep, giving easy access to small animals. The owner stated that "toads" were often brought up with the water, and he thought that the bodies of a number of these animals were in the well in a state of partial decomposition. The well had not been cleaned in any way for a number of years, and was known to contain a large quantity of decomposing vegetable matter. The taste of the water was complained of by all those who drank it. Dr. R. W. Dorsey, of Fairfax Court-House, who sent me the water and the information in regard to it, had, a short time before, seen three cases of "fever resembling, in some respects, typhus," in the family of the owner of the well; and he noted that some time previous to this there had been two cases of a similar kind in a family near by, whose drinking water was obtained from the same well.

No. 25. Well water from Andover, Mass. The water was sent to me by Dr. M. B.

Harris, of that place, as suspected by him of being connected with the ill health of the family (under his medical charge) who used it. He stated that there were two cesspools about 100 feet from the well, one on either side, both connected with springs in the ground. The well was on the eastern end of a ledge on which the house was built. On the east of the well, and about it, there was a deposit of peaty matter (filled in). The space to the east of the well (since filled in and leveled and partly occupied by a house) was originally a frog-pond, into which poured the drainage of an extensive marsh, since filled, graded, and covered with houses. The water was raised from the well by a pump, with pipes of block tin. All the members of the family, four in number, who had lived in the house through the winter, had "had follicular tonsillitis—*not diphtheritic*—nor worse nor unlike other cases in town, except in the sequelæ. Each case had been followed by great and prolonged prostration; one by sores on the joints of the fingers, and one by abscess under the arm. The whole family had been 'miserable,' not sick, for two months since the wells filled. Different servants and nurses had been in the family during the previous six weeks, but no one had been sick except those who had lived in the house for some time."

No. 26. Mississippi River water from Rock Island, Ill. Dr. G. G. Craig, of that place, wrote to me that four years previously there had been a severe epidemic of diarrhæa in Rock Island, resembling, as he thought, the "winter cholera" of Chicago; that the disease had prevailed more or less every winter since, but had not been so bad as four years past, until the last winter (1880–'81); that during this last winter there had not been so much diarrhea as four years before, but more typhoid fever; that the water supply is derived from the Mississippi River, pumped by the Holly system from the lower part of the city, several sewers emptying into the river above the water-works; and that he and some other physicians believed the intestinal disease to be due to the use of this water contaminated with sewage, while others considered the cause atmospheric. Dr. Craig added that there was but little diarrhæa at the time when the sample was sent.

No. 27. Well water from Little Rock, Ark. Dr. J. A. Dibrell, jr., secretary of the State board of health of Arkansas, wrote to me in May as follows: "During the latter part of December last, and the first few days of January, 1881, there occurred at a hotel in this city twenty-six cases of a choleroid disease, none of which proved fatal. In no other portions of the city was the disease observed, except, perhaps, three or four cases in the neighborhood of the hotel. After much investigation and inquiry on the part of the attending physicians, they came to the conclusion that the disease was caused by drinking water used at the hotel and obtained from a well on the premises. The use of the water was ordered discontinued, and no new cases occurred. The well has up to this time, I am told, not been used for any purpose." The well remaining in the same condition as when these cases of illness occurred, I received from Dr. Dibrell a sample of the water, with the following additional information in regard to the surrounding conditions obtained from Dr. D. H. Dungan, president of the board of health of Little Rock, who had made a sanitary survey of the premises. "The well is about 18 feet deep, and passes through clay and gravel in varying proportions to near the bottom, where it becomes sandy. The sewer pipe from the water-closet passes underground within about 8 feet of the well, but no leakage was discovered near it. The two lots, each 50 by 140 feet, on which the hotel is built (the building only covering the fron half of the lots), had on them before the hotel was built two or three deep vaults, which have been filled, but I cannot now discover their place. It is said that other vaults had existed on the grounds and been filled before. It is only necessary to mention the fact that our well water is found in the sandy stratum below the clay, and that many privy vaults in the city are sunk to the depth of the sand."

No. 28. Well water from near Wellsville, Ohio. This water was sent me by Dr. J. McCarrell, who suspected it of producing illness, and stated that it came from a well 26½ feet deep, sunk in clay and slaty and soapstone-like rock; that the family using the water, consisting of parents and nine children, were cleanly in their habits, settled on a farm in the country, and good livers, and that he had examined the house, cellar, and surroundings without being able to find anything to account for the cases of sickness which had occurred. During the winter of 1879–'80 all the children had diphtheria, and one child died with the malignant form of that disease. During the winter of 1880–'81, shortly before Dr. McCarrell wrote to me, there had been six cases of typhoid fever among the eight children, which were of a rather mild type, although distinctly marked, and all ended in recovery. The family had been using water from a spring, but this water not being good, the well was sunk; the water of the latter did not taste right until freezing weather set in.

No. 29. Well water from Mount Vernon, Ohio. Mr. C. P. Peterman, studying medicine with Drs. Larimore and Wilson, reported three cases of typhoid fever in the same family, the mother, aged sixty-one; a son, aged thirty, and daughter, aged thirty-five, with suspicion attaching to the drinking water used; an old privy vault standing within 10 feet of the well, the privy still in use. Dr. Larimore, the physician in

attendance on the cases in question, said that he could not speak with certainty as to the water being the cause, but he thought the circumstances "very suspicious."

No. 30. Well water, from Jonesville, Mich. Dr. H. M. Warren stated, in proposing to send a sample of this water, that he had been treating a family of the town in question more or less for twelve months, and that he considered the symptoms of his patients pointed strongly to organic pollution of the water they drank. In the family referred to the husband, a bank cashier, used but little of the water from this particular well, and did not suffer much, but his wife and two children, who used it freely, "had continual 'sick spells,' derangement of the stomach, bilious disorders, skin eruptions," &c.

A large livery stable, and the hog pens and privies of a hotel were distant not more than 120 feet from the well, and the vaults attached to the house were much nearer; all of these possible sources of pollution, and the well itself, had been in existence for twenty years or more. The well is reported as 16 or 18 feet deep, through a gravelly and sandy soil, but no rock. Analogous conditions endanger, Dr. Warren thinks, the purity of the water supply of the whole village.

No. 31. Well water, from near Adamstown, Md., sent me by Dr. W. H. Johnson, of that place. Dr. Johnson reported that some six weeks before the date of his letter typhoid fever made its appearance in the family of a prominent gentleman living about a mile from the Catoctin Mountain, a spur of the Blue Ridge on its eastern slope. Four cases occurred; in the first two, which were of most malignant character, the patients, a son of eighteen and daughter of twenty years of age, strong, hearty subjects, both died, the bodily temperature in one of these cases reaching 107 before death (during intensely hot weather in June and July). Dr. Johnson did not see these two cases himself, but learned the facts from the attending physicians; in a third case he was called in in consultation, but saw the patient daily, while a fourth member of the family showed premonitory symptoms only; both of these recovered. All of the persons attacked had used the water of the well in question exclusively. There had been no other cases in the community involving typhoid symptoms during the year up to the time Dr. Johnson wrote, though the disease is not uncommon in some localities in the neighborhood, but is usually more of the typho-malarial character, and does not occur so early in the summer without local cause.

The residence had been in the possession of the family for one hundred and eight years, during which time no epidemic had ever been known. The well in question, 40 feet deep, had been dug within the previous eight months, the spring being rather remote from the house. The nearest stable was distant from the well about 80 or 100 yards, and at the base of the hill upon which the house was placed, below, as Dr. Johnson thought, the level of the water in the well. The privy stood east of the house, about 50 yards off, just on the verge of an abrupt descent, at the base of which there is a rapid little stream, subject to a rise at every rain. This privy was above the level of the water in the well, but Dr. Johnson thought, from the contour of the ground, it was not probable, if possible, for the water to percolate through the earth for such a distance, though he added that subterranean channels are sometimes found in that part of the country, discovered by mere chance, where none had been supposed to exist. The angle of the slope on the verge of which the privy stood was at least 40°, so as to facilitate very much the washing away of filth by each rain. The soil was a red or chocolate clay, with reddish sandstone and "calico rock" underlying it, and ending with limestone at the bottom of the well. The water from the well contained visible floating particles, apparently of organic character.

No. 32. Well water from Charlotte, Mich.—This was one of three samples sent me by Dr. W. H. Rand, health officer of the town of Charlotte, under the belief that persons had suffered from their use. One of the three was lost, in consequence of the breakage in transit hither of the large glass vessel containing it, but the others arrived in good order. This sample came from the "City Park well," which is reported as about 24 feet deep to the water, passing through beds mostly of sand and gravel. The well is about 200 feet from a cesspool, which is of about the same depth, and receives all the dirty water, fæcal matter, &c., from the county jail. "The inmates of the jail, as well as all those using this water, had suffered more or less from some of the graver diseases, as diphtheria and typhoid fever, there having been six cases of the former and three of the latter during the previous autumn, within two months." The pump used was an ordinary iron one.

No. 33. Water from another well at Charlotte, Mich.—This sample, also received from Dr. Rand, came from a well of about the same depth and passing through the same porous material as the preceding; it is situated in the rear of the principal public house of the town, and is distant 10 feet from a small privy vault, 75 feet from a very large one, and 65 feet from two large cesspools, beside which there are two barns within 50 feet. The water is believed to have produced intestinal diseases. It is drawn from the well by a common iron pump.

No. 34. Well water from Jacksonville, Fla.—Dr. C. Drew, of Jacksonville, who sent me this water, stated that within a couple of months he had attended a family of

some twelve persons, of whom five had been attacked by an obstinate type of fever, resembling in some of the cases an obstinate remittent, in others well-marked typhoid. In all the cases of enteric fever which he had seen in the place he had had reason to suspect the drinking water, and had always directed a change of water at once. He had known of no instance in which so many cases had developed in the same household as this, and of none in which he had had such good reason to suspect polluted drinking water as the cause. The well was 21 feet deep, with 3 feet of water. The ground was rather level on the surface, with some tendency on the part of rain water to stand for some time. The superficial stratum was siliceous sand, with a subsoil, Dr. Drew thought, of clay. The well was within 20 feet of the sink, which was very shallow—perhaps 18 inches in depth—and there had been five or six old sinks in the immediate vicinity which had been filled up. All the wells of the neighborhood received more or less surface water.

No. 35. Water from a "driven well" at Asbury Park, N. J.—The sample was received from Dr. Henry Mitchell, of Asbury Park, who wrote, in offering to send it, that eight cases of diarrhœa, one of dysentery, and one of inflamed sore throat had occurred in one building, that was supplied with this water, during the previous week; that the cesspool and privy-vault were made of brick and cement, and were connected with a street sewer, but that the water supply was taken from "a driven well within a few feet (15?) from both the cesspool and the vault," and that there might be leakage of these receptacles; that the building was a large boarding-house, and that the health of the inmates was generally impaired. The cases of illness had been attended by several physicians. Somewhat later, after sending the sample of water, Dr. Mitchell wrote that, on his attention being first called to the state of health of the inmates of this house, he learned on inquiry that diarrhœa had been prevailing among the children, and to some extent among the adults who were boarders in the house. On the following day he saw Miss M., who had suffered from repeated attacks of diarrhœa, and who was then suffering from an abcess in the axilla. On the next day Mrs. S. was attacked by diarrhœa. She also had numerous small abcesses. Four days later Mr. M. was attacked by diarrhœa, which became dysentery. Within the following week several cases of diarrhœa occurred in the building. An infant there died from congestion of the brain, occurring in the course of an attack of diarrhœa. Still later a number of cases of illness occurred in the building, the number and details of which had not been learned. A week after the first cases had been seen, Miss. H. was attacked by ulcerative tonsillitis, which proved to be severe, and from which she was still suffering when Dr. Mitchell wrote, three weeks later. He further stated that the privy-vault received the sink waste and house slops, and was connected with the public sewer, but that on several occasions the sewer-pipe had been obstructed, and the vault had overflowed, saturating the surrounding soil with the filthy fluids.

No. 36. Well water from Huntingdon, Pa.—The sample was sent me by Dr. A. B. Brumbaugh, with the following statement: Huntingdon is supplied with drinking water from wells. The old part of the town is about one hundred years old, and has been pretty well honeycombed by privies. In this old part of the town a part of a square occupied by citizens in good circumstances had been for some time suspected of having the water contaminated. In one of the families living here, at the lower part of the square, which slopes toward a small stream, two of the household, the mother and a son, had been attacked by typhoid fever about a month before Dr. Brumbaugh first wrote. Two weeks later, a daughter, a young lady twenty-one years of age, was taken with the fever, and died after an illness of rather more than a fortnight. About a week before her death the father was attacked. There were still three other members of the family, of whom one had premonitory symptoms of the disease. Dr. Brumbaugh sent a sketch map of the locality, showing that the well supplying the water which had been used by all the patients referred to was a good deal surrounded by buildings, and within about 60 feet of several privies (without outlets from the vaults), lying in more than one direction; a wash-house was also close by, and the hotel stable, occupied daily by horses, was about 120 feet off. This sketch also shows the positions of neighboring houses in which several cases of typhoid fever and one of diphtheria had occurred during the previous year, with two or three deaths. These dwelling had separate but quite similarly situated wells.

No. 37. Water from a shallow well at Meridian, Miss.—This water was sent me by Dr. M. J. Lowry, health officer of Meridian, as suspected of being the cause of typhoid fever. It came from a well of only about 8 feet in depth, situated in a flat place in the business portion of the town. The soil is sandy, and shallow wells like this fill up to the top after slight rains. There were a great many cases of typhoid fever at the time the sample was sent (near the end of August), and dysentery had prevailed earlier in the summer. Most of the local physicians looked upon the drinking water from these shallow wells as the chief cause.

No. 38. Well water from Lexington, Sanilac County, Michigan.—A letter from Dr. A. M. Oldfield, of this place, stated that there had been in a single family, consisting of six members, two well-marked cases of typhoid fever—children of five and eight

years old—and two other cases of premonitory symptoms of the same disease—a child of three and an adult of thirty-two years old. The father, whose business called him away most of the time, had no symptoms of the disease, and the same was true of the baby, which was nursing. The water exclusively used in the house was from a well of 20 feet depth, through a clay soil, receiving the water from a gravelly seam about 9 feet from the surface. When Dr. Oldfield first wrote the water was 6 feet deep in the well, but a week later it was not more than 18 inches. The well was sunk about a year before, and was lined with stone and covered with plank, and the earth sloped off from it all round. The premises had been occupied by different persons for more than forty years, and the privy had stood on different places in the yard to suit the several occupants. The present privy was about 70 feet from the well, with drawers, and dry earth and ashes were used as absorbents, being afterwards emptied out on the garden, on the same lot. There was a barn about 75 feet from the well. Dr. Oldfield was strongly inclined to believe that the cases of typhoid fever were attributable to the use of this well water, but added that another family, of four persons, all adults, however, used the same water wholly, with no apparent bad result, and that other families in the neighborhood used it occasionally.

Appendix to Class II.

No. 39. Spring water from near Charlottesville, Va.—The circumstances connected with this case were such that it would be clearly improper to include it in Class II, while it would be wrong to omit it (or any other case examined) from publication, the more so that it furnishes an instructive illustration of the sources from which mistakes may arise in regard to sanitary matters. One of the most intelligent and scientific physicians of this neighborhood, Dr. W. C. Dabney, was kind enough to promise to look out for and inform me of any case of enteric disease in which he thought there was really good ground for suspecting drinking water as the cause, and at the beginning of September he wrote to me in reference to a case of "very well marked and moderately severe" typhoid fever in a negro girl about fourteen years old, as follows: "There is a very strong probability that the disease in this case was brought on by contaminated water. The spring from which the family obtained their drinking water is within a yard of a little stream which receives the offal and filth from a slaughter house, and the spring itself I found on examination to contain maggots and filth of every description. This girl stayed at home, and used this water much more than the other members of the family, who were away all day. Last summer typhoid fever broke out in a family occupying the adjoining lot, who also used this contaminated water, and three of the six members, I believe, died. If you think it desirable to examine this water, I can readily obtain some for you. I myself do not think there is a reasonable doubt but that it is instrumental at least in producing the fever."

A messenger, guided by Dr. Dabney's directions and by the negro family in question, procured a sample of the water, which was regularly examined by all three analysts. The case being apparently a very well marked one, I looked with interest to the reports as they came in, and was not a little surprised to find that, as will be seen from the main table of results, the bad character attributed to the water was by no means sustained, judging by the rules which have usually been applied. Informing Dr. Dabney of this, he kindly visited the spring again, his patient having in the meantime convalesced, and found that its condition was altogether different from that observed some time before, when he had first written to me. The long-continued and severe drought of the autumn of 1881 had in great measure dried up the little stream which had brought the slaughter-house refuse, and the spring was free from anything objectionable in its appearance or other sensible properties. There seems to be no reason to doubt that the spring water *was* badly polluted when first noticed by Dr. Dabney, and was very probably the cause of the disease which he treated, but that the pollution came altogether from the overflow or sepage of the foul water in the little stream, while the spring water of itself was good and wholesome, and that my sample was taken after the connection with the stream had been practically cut off by drought affecting the latter. It is obvious that the case would have been a puzzling one if it had occurred under circumstances which did not admit of full investigation.

Class III.—*Natural waters of doubtful but more or less suspected character.*

No. 40. Well water from Port Chester, Westchester County, New York.—This water, from a well on the premises of Mr. M. O. West, was sent me by him with the statement that his family had been ailing for nearly a year—"no diarrhœa, cholera morbus, or dysentery, but a kind of general debility"—and that the family physician thought the water used was the cause of the trouble. The house was built upon a rocky knoll; the well passed through 2 feet of surface soil and 16½ feet of solid rock, making 18½

feet to bottom, with a depth of 10½ feet of water in it; the ground surface at the well was 6 feet above that at a privy distant 24 feet, and there was thence a further fall of 40 feet to the river, distant 140 feet; the well was curbed with stone, and had been thoroughly cleaned out at least three times within three years. On asking for further medical testimony, Mr. West sent me a statement from his family physician, Dr. E. F. Mathews, to the effect that the household consisted of four persons, two adults and two children, the latter five and seven years old; that they had been generally quite healthy previous to the time of living in their present home; that the house stands on solid rock, is heated by a furnace in the cellar, and has no bath room nor water-closet within doors; and that since living in this house all the family have suffered from various disorders of the digestive and nervous systems, generally malarial, and yielding only to treatment with quinine. Dr. Mathews added that the house is situated within about 100 feet from a tide-water mill-pond, whose highest level is about 25 feet below the ground floor of the house.

No. 41. Well water from Closter, Bergen County, New Jersey.—This came from a well used by Mr. F. C. Tomlinson, who wrote that he had first suspected the water at a time when there was a short supply, when it had a peculiar and disagreeable smell, which as the supply increased gradually disappeared; that whenever the water was boiled the vessel containing it and the cup used to dip it out were soon coated with a whitish or light brown substance, easily rubbed off and soft to the touch, something like soapstone; that the water was used for all household purposes, and was exceedingly soft. Dr. H. A. Crary, the family physician, furnished the following statement: That he had been familiar with the premises where Mr. Tomlinson resides since 1868, and had always considered it a healthy locality, there having been very little sickness among the occupants before Mr. Tomlinson moved to the place; that in 1880 he (Dr. C.) was called to attend Mr. Tomliuson's son, whom he found in the last stages of phthisis pulmonalis, and who showed some symptoms of malarial trouble, for which quinine was prescribed; that some months afterwards Mr. Tomlinson suffered from sub-acute adenitis, the cervical glands being much swollen, with extensive infiltration of the areolar tissue, followed by slow suppuration, with much disturbance of the general health, which was rapidly restored by the use of iron and quinine; that Mr. Tomlinson's health had afterwards remained good up to date; and that he (Dr. C.) attributed the attack to malarial poisoning. No particulars as to the depth and surroundings of the well were obtained.

No. 42. Well water from near Ripley, Miss.—This was sent me by Dr. W. D. Carter, who informed me that, as health officer, he had visited the place, about 4 miles from Ripley, where three cases of illness, with two deaths, had occurred under the following circumstances: The family consisted of nine members, parents and seven children. The county at the time was healthy, not a case that could be attributed to malaria within an area of eight or ten miles. The weather was hot for July, the thermometer ranging from 90° to 98° in the shade and in the coolest houses. Dr. Carter derived his information as to the cases of illness, not from the physician who had been in attendance, but from the father and another relative. After walking to church, a mile or more, three of the children were violently attacked with pain in the head and spine and general restlessness. The eldest, a girl of twelve years old, died the first week. The second, also a girl, died on the twelfth day of her illness; two days before her death the action of her heart was feeble, her temperature low, the head drawn back, pupils contracted, and corneæ injected. The third case recovered; a boy four or five years of age. The situation of the premises was not good; the house on the side of a hill; well supplied by sepage water, and within 10 feet of the meat-house; the garden, 50 feet in width, above the well; the cow-pen on the summit of the hill. Dr. Carter considered the disease to be "cerebro-spinal meningitis, produced by soil pollution." The above statement seems to suggest exposure to high temperature as a more probable cause of the symptoms than impure water. I was informed that there was not so much water in the well when the sample sent me was shown as when, three or four weeks previous, the cases of illness and death had occurred, the weather having been dry in the meantime.

No. 43. Well water from Union City, Tenn.—Two samples, from different wells, were sent by Dr. S. T. Evans, but the vessel containing one of these was broken on the way, and the other only was examined. This came from the well of Dr. J. B. Harrison. Dr. Evans stated that he did not then suspect the well water of the place of producing disease, "unless it be winter malarial fevers in those who have not suffered from them before freezing weather," but that in 1873 there had been a terrible epidemic of cholera, which many persons believed to be caused by the drinking water of the place. Dr. Evans said that he himself and most of the other physicians of the place did not join in this belief, but that they wished to have the water examined. He remarked that the local diseases are "principally malarial, with a decided increase in the direction of typho-malarial." The water of the place comes from wells dug to the depth of 15 to 50 feet, and walled up with hard brick, the water being

generally drawn with well ropes and wooden buckets. The samples sent me were considered typical.

No. 44. Hudson River water, from Poughkeepsie, N. Y.—Dr. H. J. Cate, of Poughkeepsie, wrote to me that that place is supplied with water by pumping from the Hudson River, the water being filtered before it is raised to the distributing reservoir; that many persons have good wells, but that the water is so very hard as to be rarely used; that before the introduction of the river water filtered cistern water was in very general use, but that of late people have been giving it up and using the river water more and more; that he and other physicians "feel certain that families using the river water are more susceptible to attacks of diarrhœa, and that it is more difficult to cure them than in families using cistern water; and last winter, when the Hudson was frozen over for a long time, so that the water could not be purified from organic matter, either by contact with the air or by the growth of aquatic plants in itself, we had an epidemic of diarrhœa, difficult of cure, and repeatedly recurring unless the patients were kept from use of the river water." In a subsequent letter Dr. Cate says: "I send some details of cases very common here, for which we hold the city water to be responsible. February 23, 1881, *et seq.*: Family of four all ill with diarrhœa for several weeks, sometimes better for a few days, but soon recurring, and not yielding to treatment. One member of the family was at once relieved by a temporary absence from the city, but the trouble reappeared on his return to the use of the city water. On stopping the use of the water the diarrhœa soon disappeared, but reappeared in two members of the family at each return to the use of the city water. This has been a common experience with physicians in all sections of the city. We have reason to believe that it is a frequent cause of typhoid fever and that it impresses a typhoid character on other diseases."

Perhaps this water ought to have been placed in Class II. It is, on the whole, placed here without looking at or knowing anything of the results of its examination.

No. 45. Water from Trinity River, Dallas, Tex.—Dr. J. L. Carter, health officer, and Mr. W. C. Connor, president of the Water Supply Company of Dallas, wrote to me that this river water was about to be introduced, in a filtered condition, into the public mains of the town, the supply from certain springs having ceased to be sufficient, and that there was some apprehension as to the character of the water. Dr. Carter stated that "the river gets quite low in summer, but always flows. The course of the river is over limestone rock and coarse sand for miles, and through timber. The valley has no farms, but the hills or uplands are mostly in cultivation through its entire length." A letter of inquiry from a citizen of Dallas, of later date, speaks of the Trinity River as "a slow, narrow, shallow, little stream, that carries away all the filth of Fort Worth (on its banks), 35 miles above." The sample sent me was taken from the river just above the town of Dallas.

No. 46. Water from a small brook, subject to pollution, at Bordentown, N. J.—This and another sample of water were examined at the request of Dr. H. H. Longstreet, president of the local board of health, who sent the following statement: The public water supply of Bordentown is derived from Crosswick's Creek, a small stream of 20 miles in length; the water is pumped from the creek and forced into a reservoir half a mile from the town, and thence distributed by iron pipes. At the eastern border of the town is a small brook of rapidly flowing water, which receives the drainage from the entire northeastern section of the town. This brook empties into Crosswick's Creek at a point 575 yards distant from where it (the brook) first receives the discharge from the city sewer. The distance from the outlet of the brook into Crosswick's Creek to the supply-pipe of the water-works is 325 yards, making a total distance of 900 yards from the opening of the city sewer into the brook to the supply pipe of the water-works. Into this same brook, at almost the same spot where empties the city sewer, there discharges a recently constructed drain, affording the channel for carrying off the refuse from a large "tomato-canning" factory, consisting chiefly of the waste juice and washings of the tomatoes. This factory, however, is only at work during the season of about nine weeks from the end of July to the beginning of October, and there was no discharge from its drain at the time when the sample sent me was taken. This sample was taken from the deepest part of the brook in question, and care was exercised in removing it without disturbing the deposit at the bottom of the stream.

No. 47. Water from Crosswick's Creek at Bordentown, N. J.—This, the second sample sent me by Dr. Longstreet, was taken from the creek just as it was pumped up at the water-works, as above described. It represents the public water supply of the place at the time both specimens were collected, the canning factory not in operation.

No. 48. Well water, used as the chief source of public water supply at Titusville, Pa.—Mr. T. L. Hobart, secretary of the board of health of Titusville, informed me that the ordinary supply of water in the mains of that town is derived from public wells, dug about 18 feet deep, and cemented, except at the bottom, where the water comes in from a bed of gravel. The wells and pumping machinery are outside of the

town limits, about a mile from the center of the town. As the water-bearing stratum is understood to incline from the hills toward Oil Creek, it is believed that the water receives but little contaminating material from surface impurities or sepage. A cemetery is situated on rising ground about 1,500 feet from the wells, but as yet there have been but few interments. Not many houses have been built in the immediate vicinity. The water is pumped directly from the wells into the mains, no reservoir being used. There was some little apprehension felt as to the character of the water, and the health authorities wished to have it analyzed, although Mr. Hobart informed me that the previous year had been one of good general health in the community, with a low death rate, and no epidemic except one of measles in a mild form.

No. 49. Water of Oil Creek, occasionally used as part of the water supply of Titusville, Pa.—Mr. Hobart further wrote that when the consumption or waste of water is unusually large, as in the heat of summer, extremely cold weather in winter, and on the occurrence of fires, the wells above mentioned do not afford a sufficient supply, and at such times the water of Oil Creek is introduced into the mains, just as it runs, without filtration. This stream has its rise in Oil Creek Lake, about 15 miles from Titusville, and in its course passes through two or three small towns and much intervale and wooded land, receiving more or less contaminating material. The same motive for desiring an analysis existed as in the case of the well water. The sample sent was taken directly from the creek itself.

No. 50. Well water from Newport, R. I.—Prof. Raphael Pumpelly, having had referred to him certain questions as to the drinking waters of Newport by the Sanitary Protection Association of the place, wrote to me, expressing a desire to obtain a chemical examination of the water derived from "a very important well from which a very large amount of mineral water is manufactured, and which is considered by many to be the best well in the city." He added: "The conditions surrounding this well are so very bad, such as slaughtering-houses, cesspools, and surface drains, &c., that it may well be suspected." Two samples were sent, representing the water before and after filtration. This, numbered 50, was taken from the tank into which the water is pumped directly from the well.

No. 51. Same well water from Newport, R. I., after filtration.—This sample was taken from the feed-pipe after having passed through the "clarifying and purifying filter" used by the mineral water establishment referred to.

No. 52. Public water supply of Newport, R. I., as used on board the United States flagship New Hampshire.—A letter received from Dr. J. L. Neilson, passed assistant surgeon, in charge on board the United States vessel named, then stationed at Newport, stated that the water used on board the ship was the city water, originally pumped from a large pond, called Easton's, into a reservoir, and thence distributed by gravity; that there had been no evidence of disease of any kind originating from the use of the water, the health of the vessel having been very good since she had been in commission, but that the water had caused a great deal of unfavorable comment on account of its unpleasant odor and its color, caused by the presence of a number of vegetable organisms of low origin, supposed to be *Protococcus viridis*. Dr. Neilson added that he was prepared to say with positiveness that neither odor nor taste was caused by any defects in the ship's tanks or in transportation, as he had personally examined into these possible sources of contamination, and as, moreover, the same disagreeable odor and taste were perceptible in the water as delivered from the pipes at various houses in Newport. The sample sent was taken from the tanks of the New Hampshire.

No. 53. Water derived from the melting of ice cut from Almy's Pond, Newport, R. I.—Early in the course of this investigation, Dr. H. R. Storer, corresponding secretary of the Sanitary Protection Association of Newport, wrote to me, stating that the council of the association wished to obtain a chemical examination of the ice, or the water obtained on melting the ice, used by the greater portion of the families of the place; that there was reason to suspect such impurity in the ice as to render it unsafe for domestic use, the pond within the city limits from which it was procured being shallow, and having barnyards, privies, and cesspools upon its immediate margin, and draining an area within which there were still others at no great distance, and that no one would think of using the unfrozen water of this pond for drinking purposes, though many people were disposed to believe that it underwent sufficient purification in the act of freezing. The sample of water for examination was sent by Professor Pumpelly, at the request of Dr. Storer, and was obtained by melting the ice in question in a perfectly new copper tank.

No. 54. Mississippi River water, taken from just below the point at which the city garbage of New Orleans is thrown in.—Besides the specimens of water from the Mississippi River as used for drinking purposes in New Orleans (Nos. 17 and 18, above), which were procured for me by the kindness of Dr. S. M. Bemiss, two other specimens were sent of the river water after it has received polluting material from the city: it is to be remembered, of course, that there is no *drainage* from the latter into the river. This sample (No. 54) was collected from the river between its center and the

New Orleans bank, immediately below the point at which the city garbage is dumped from the garbage boats, and near by the point at which the city slaughter-house is situated. The dumping of garbage takes place at 7 p. m. every evening; the sample was collected at 7 a. m.

No. 55. Mississippi River water from a point lower down stream than the last.—This sample was collected on the same morning and nearly at the same time with No. 54, from mid-river, and at a point half a mile lower down the stream.

No. 56. Water from the "Old Basin," New Orleans.—The old and new basins and canals that reach the heart of the city of New Orleans from Lake Pontchartrain are used for transportation only, not for drinking purposes. Having but one outlet, the lake, their generally stagnant condition has caused them, however, to be regarded as probably injurious to the health of the neighborhoods through which they pass.

No. 57. Water from the "New Basin," New Orleans.—The surroundings and condition of these two canals make it highly probable that they are quite unfit for use for drinking purposes, while, as they are not in fact so used, there is no direct evidence as to the water being capable of causing disease.

No. 58. Well water from a somewhat suspected well at the University of Virginia.—The well in question has in all probability less depth than any other in or about the university premises; it is 32 feet deep, but the ground falls off abruptly some 9 or 10 feet immediately on one side, while on the other there has been artificial filling. The distance from the well on the higher side to a sewer, slenderly constructed of brick and cement, is about 30 feet. The well is sunk through red clay, and is fitted with an old-fashioned wooden pump.

No. 59 Pond water from near the University of Virginia.—This sample was taken from a pond used for the collection of ice, at a point on the margin where the depth of water is but 4 or 5 inches, and immediately below a stable situated on the slope of the bank 40 or 50 yards off. There was no visible surface drainage from the stable to the pond at the time when the sample was taken, but rain must undoubtedly wash down impurities.

CLASS IV.—*Artificially prepared waters, made by adding to good, wholesome water determinate amounts of various infusions of vegetable organic matter of natural origin.*

No. 60. Normal hydrant water, with one-fifth per cent. of an infusion* of fresh, unbruised green herbage (chiefly mixed grasses), such as water would be in contact with in flowing over or standing upon ordinary meadow or pasture land.

No. 61. Similar mixture, containing 1 per cent. of the herbage infusion.

No. 62. Similar mixture, containing 5 per cent. of the herbage infusion.

No. 63. Normal well water, with one-fifth per cent. of a pretty strong, dark-colored infusion, made from dry, rather coarse hay (chiefly mixed grasses, with some sedge), representing the dried-up vegetation on meadow land when allowed to stand into late summer or autumn.

No. 64. Similar mixture, containing 1 per cent. of the hay infusion.

No. 65. Similar mixture, containing 5 per cent. of the hay infusion.

No. 66. Normal hydrant water, with one-fifth per cent. of an infusion of dry, fallen forest leaves (oak, maple, dogwood, &c., chiefly oak), such as surface drainage water, by standing in or flowing through a forest-covered country, is brought extensively into contact with.

No. 67. Similar mixture, containing 1 per cent. of the infusion of leaves.

No. 68. Similar mixture, containing 5 per cent. of the infusion of leaves.

No. 69. Normal hydrant water, with one-fifth per cent. of an infusion of dark-colored, nearly black, humus or mold from the inside of an old log in the forest.

No. 70. Similar mixture, containing 1 per cent. of the humus infusion.

No. 71. Similar mixture, containing 5 per cent. of the humus infusion.

No. 72. Normal hydrant water, with one-fifth per cent. of an infusion of dark-colored, humoid, sandy soil, which had been in cultivation, but had received no recent manure.

No. 73. Similar mixture, containing 1 per cent. of the humoid soil infusion.

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*In the preparation of this and all the other artificially prepared waters, the quantities of material mentioned are those *in the mixture as examined—e. g.*, in this case the mixture consisted of 99.8 per cent. of normal water +.2 per cent. of the herbage infusion. The infusions were prepared with the same water as that afterwards used to dilute them, and at common atmospheric temperature, allowing the water to stand on solid materials for about twenty-four hours. The "normal hydrant water" used was that drawn at the chemical laboratory of the University of Virginia from the university reservoir, fed by springs (Nos. 6, 7, and 8, above).

The "normal well water" was that obtained from the well at the house of the university janitor (Nos. 9 and 10, above). This latter had to be resorted to when, during the summer drought of the autumn of 1881, the supply from the reservoir failed.

Both waters were submitted to partial examination by myself from time to time so as to observe any changes in the amounts of the principal constituents, and these were observed afterwards, subtracting the same from the results for the mixtures.

No. 74. Similar mixture, containing 5 per cent. of the humoid soil infusion.

No. 75. Normal hydrant water, with one-fifth per cent. of a somewhat weak infusion made from a dry specimen of Irish peat which had been in the laboratory for several years. The peat was torn asunder, and to some extent crumbled up, before pouring the water over it.

No. 76. Similar mixture, containing 1 per cent. of the peat infusion.

No. 77. Similar mixture, containing 5 per cent. of the peat infusion.

No. 78. Natural peaty water from Lake Drummond, in the Dismal Swamp, Norfolk County, Virginia —Mr. E. A. Hatton, of Portsmouth, Va., who was kind enough to procure for me this and the next specimen of the dark, peaty water of the Dismal Swamp, informed me that three such waters might be distinguished: 1, this water of Lake Drummond, in the interior of the swamp, lightest in color, which has been spoken of as a source of supply for Portsmouth and the United States navy-yard; 2, water from the Dismal Swamp Canal, intermediate in color, and in a part of the course of the canal brackish; and 3, water from what are locally known as "springs," *i. e.*, holes made by the uprooting of trees and filled with water, this being darkest in color.

No. 79. Dark-colored peaty water from holes made by uprooting of trees and filled with water, in the Dismal Swamp, Norfolk County, Virginia.—This was a sample of the water from the so-called springs above referred to.

Nos. 78 and 79 are placed in Class IV, although not artificial mixtures; they represent water containing the soluble matter extracted under natural conditions from peat, a special and well-defined form of vegetable matter, whose sanitary relations to water supply have attracted a good deal of attention, and which is more extensively distributed and of more practical importance in some other countries than, on the whole, it is in the United States.

CLASS V.—*Artificially prepared waters, made as above with various forms of vegetable refuse from manufacturing or industrial operations.*

No. 80. Normal hydrant water, with one-fifth per cent. of the drainings from a sawdust heap (pine sawdust).

No. 81. Similar mixture, containing 1 per cent. of the sawdust drainings.

No. 82. Similar mixture, containing 5 per cent. of the sawdust drainings.

No. 83. Normal hydrant water, with one-fifth per cent. of the sour drainings from a pile of tan-bark. These drainings formed a nearly clear, very dark brown liquid. The bark was piled in the yard of an establishment for making tanning extracts, that of John H. Heald & Co., Lynchburg, Va. There were no hides nor other animal material about.

No. 84. Similar mixture, containing 1 per cent. of the tan-bark drainings.

No. 85. Similar mixture, containing 5 per cent. of the tan-bark drainings.

No. 86. Normal well water, with one-fifth per cent. of the alkaline washings from the preparation of wood-pulp for the manufacture of paper, obtained from the Montague Paper Company, of Turner's Falls, Mass. After the wood has been disintegrated by digestion in a boiler with caustic soda solution, it is washed repeatedly with water, the stronger washings being saved for the purpose of recovering the alkali, while the weaker washings are run off into the river. The liquid was dark brown in mass. The pretty rapid extension of the manufacture of paper from wood pulp, and the large scale upon which it is carried on, tend to give this form of refuse a considerable degree of practical importance from a sanitary point of view.

No. 87. Similar mixture, containing 1 per cent. of the alkaline wood-pulp washings.

No. 88. Similar mixture, containing 5 per cent. of the alkaline wood-pulp washings.

No. 89. Normal well water, with one-fifth per cent. of the alkaline washings from a (maize) starch factory. This material was obtained from the Glen Cove Starch Manufacturing Company (Messrs. Duryea), Glen Cove, Long Island, N. Y. It appeared as a yellowish milky liquid, with very foul smell, produced by treating the grain with alkali to disintegrate it before washing the starch, and then washing freely with water; both albuminoids and fatty matter are carried off, with some little starch; this liquid is run off to waste.

No. 90.—Similar mixture, containing 1 per cent. of the alkaline starch washings.

No. 91.—Similar mixture, containing 5 per cent. of the alkaline starch washings.

No. 92.—Normal hydrant water, with one-fifth per cent. of the washings from the bag filters of a (cane) sugar refinery. This material—a dirty, turbid liquid—came from the large refinery of Messrs. Havemeyer & Elder in Brooklyn, N. Y. The waste liquid is run off quite hot into the East River. By the kind aid of Mr. P. Casamajor, the bottles used to send the liquid to the University of Virginia were filled with the liquid while still hot, and at once well closed, so as to prevent fermentation change on the way.

No. 93.—Similar mixture, containing 1 per cent. of the washings from bag filters used in sugar refining.

No. 94.—Similar mixture, containing 5 per cent. of the washings from bag filters used in sugar refining.

No. 95.—Normal hydrant water, with one-fifth per cent. of the washings from the bone-black filters of a (cane) sugar refinery. This material, which came from the same establishment as the preceding, and was sent hither with the same precaution as to bottling while yet hot, was a nearly clear liquid, almost colorless, with a peculiar, somewhat empyreumatic smell. It also is discharged hot into the river. The bone-black is assumed to have been well charred, so that no animal matter was present.

No. 96.—Similar mixture, containing 1 per cent. of the bone-black filter washings of sugar refining.

No. 97.—Similar mixture, containing 5 per cent. of the bone-black filter washings of sugar refining.

No. 98.—Normal well water, with one-fifth per cent. of the refuse from a tomato-canning factory. The factory whence this refuse material came is situated at Borden-town, N. J., and is the one referred to by Dr. Longstreet in connection with the water supply of that place (see above, Nos. 46 and 47). Tomatoes formed the only material treated at the factory when the sample was sent. This sample consisted of a reddish, turbid liquid, with much solid matter in suspension. It was strained through muslin before being mixed with the water, so as to remove the seeds and coarser shreds of the pulp and skin of the tomatoes, in order to admit of a uniform mixture being obtained.

No. 99.—Similar mixture, containing 1 per cent. of the tomato-canning refuse.

No. 100.—Similar mixture, containing 5 per cent. of the tomato-canning refuse.

CLASS VI.—*Artificially prepared waters, as above, made with animal (or partly animal) organic matter of natural origin.)*

No. 101.—Normal well water, with one-fifth per cent. of normal human urine (specific gravity=1021).

No. 102.—Similar mixture, containing 1 per cent. of urine.

No. 103.—Similar mixture, containing 5 per cent. of urine.

No. 104.—Normal hydrant water, with one-fifth per cent. of an infusion of normal human feces. The infusion was strained through very fine muslin to remove all but the finest solid matter in suspension.

No. 105.—Similar mixture, containing 1 per cent. of same infusion of fæces.

No. 106.—Similar mixture, containing 5 per cent. of same infusion of fæces.

No. 107.—Normal hydrant water, with one-fifth per cent. of the drainings from the manure pile of a (mule) stable.

No. 108.—Similar mixture, containing 1 per cent. of the stable-manure drainings.

No. 109.—Similar mixture, containing 5 per cent. of the stable-manure drainings.

No. 110.—Normal hydrant water, with one-fifth per cent. of rather dilute mixed sewage from one of the largest sewers at the University of Virginia, collected at 3 p. m.

No. 111.—Similar mixture, containing 1 per cent. of same University of Virginia sewage.

No. 112.—Similar mixture, containing 5 per cent. of same University of Virginia sewage.

113.—Normal hydrant water, with one-fifth per cent. of mixed sewage from one of the public sewers of Richmond, Va.

No. 114.—Similar mixture, containing 1 per cent. of same Richmond sewage.

No. 115.—Similar mixture, containing 5 per cent. of same Richmond sewage.

No. 116.—Normal hydrant water, with one-fifth per cent. of mixed sewage from Washington, D. C., from Fourteenth-street public sewer, between H and I streets (northwest), collected at 2 p. m.

No. 117.—Similar mixture, containing 1 per cent. of same Washington sewage.

No. 118.—Similar mixture, containing 5 per cent. of same Washington sewage.

No. 119.—Normal hydrant water, with one-fifth per cent. of an infusion obtained by allowing the body of a dead cat (not crushed or wounded) to macerate in water for ten days in hot weather. Maggots were developed in abundance, and it was necessary to strain the liquid through muslin before diluting it.

No. 120.—Similar mixture, containing 1 per cent. of the same dead animal infusion.

No. 121.—Similar mixture, containing 5 per cent. of the same dead animal infusion.

CLASS VII.—*Artificially prepared waters, as above, made with animal refuse from manufacturing or industrial operations.*

No. 122.—Normal well water, with one-fifth per cent. of diluted bullock's blood, prepared by receiving the blood directly from the arteries of the slaughtered animal into an equal volume of water, with a little magnesium sulphate to prevent coagula-

tion. This first dilution was well shaken up, to uniformly distribute the corpuscles, before further diluting it to the different standard strengths.

No. 123.—Similar mixture, containing 1 per cent. of same diluted bullock's blood.

No. 124.—Similar mixture, containing 5 per cent. of same diluted bullock's blood.

No. 125.—Normal hydrant water, with one-fifth per cent. of the mixed drainings from a slaughter-house, consisting of blood, bile, urine, &c., somewhat diluted with water, in a very foul state of decomposition, containing maggots, and smelling abominably—strained through muslin.

No. 126.—Similar mixture, containing 1 per cent. of same slaughter-house drainings.

No. 127.—Similar mixture, containing 5 per cent. of same slaughter-house drainings.

No. 128.—Normal well water, with one-fifth per cent. of the washings from raw wool. This material was procured from the Charlottesville Woolen Mills, Charlottesville, Va., and appeared as a rather thick, turbid, grayish liquid.

No. 129.—Similar mixture, containing 1 per cent. of the washings from raw wool.

No. 130.—Similar mixture, containing 5 per cent. of the washings from raw wool.

No. 131.—Normal hydrant water, with one-fifth per cent. of very dilute drainings from the soaking of hides at a tannery at Richmond, Va., before the tanning process was begun.

No. 132.—Similar mixture, containing 1 per cent. of same drainings from soaking of hides before tanning.

No. 133.—Similar mixture, containing 5 per cent. of same drainings from soaking of hides before tanning.

No. 134.—Normal hydrant water, with one-fifth per cent. of the washings from scraps of skin, after liming, and deposition of most of the surplus lime from the wash water, in pits, in the manufacture of glue. This material was procured from Peter Cooper's glue factory, New York. It appeared as a turbid liquid, with suspended whitish matter in a state of fine subdivision, greasy as from lime soap, and having a very foul smell.

No. 135.—Similar mixture, containing 1 per cent. of washings of skin scraps (manufacture of glue).

No. 136.—Similar mixture, containing 5 per cent. of washings of skin scraps (manufacture of glue).

CLASS VIII.—*Artificially prepared waters, as above, to which had been added morbid products from certain diseases in the human subject.*

No. 137. Normal well water, with 1 per cent. of the semi-fluid intestinal dejecta from a typhoid-fever patient. This material was procured for me by Dr. W. C. Dabney, of Charlottesville, Va. The case has been referred to above, in connection with water No. 39. The patient was a negro girl, about 14 years old, and the case was "*a very well marked* and moderately severe one." The discharge had the characteristic "pea soup" appearance. It was strained through muslin to remove the coarser solid fragments.

No. 138.—Normal well water, with 1 per cent. of the semi-fluid intestinal dejecta from a second typhoid-fever patient. This case also occurred in the practice of Dr. Dabney, of Charlottesville. The patient was a young adult, who had the disease very severely, and had had several profuse hemorrhages from the bowels. The coarse solid fragments were strained out, passing the still turbid fluid portion through muslin.

No. 139.—Normal hydrant water, with 1 per cent. of the liquid obtained by macerating for 12 hours in a small quantity of water the scurf flakes from scarlet-fever patients. The material in question came from one negro adult and two white children in Charleston, S. C., during the prevalence of the disease in that city, and was procured for me by Drs. Porcher and Memminger. The product of the maceration was strained through muslin.

No. 140.—Normal hydrant water, with one per cent. of "black vomit" from a fatal case of yellow fever. This material was kindly procured for me at Havana, Cuba, by Dr. D. M. Burgess, sanitary inspector for the National Board of Health, and was packed and sent with special precautions. The patient who vomited it died about twelve hours after ejecting it, and in the sixth day of yellow fever. The specimen was characteristic, and was strained through muslin. It had been very carefully sealed up, and had undergone less change than might have been expected from the time occupied in its transmission (though this was as short as possible) and from the heat of the weather.

CLASS IX.—*Solutions in distilled water of carefully determined amounts of pure substance of definite chemical composition.*

No. 141.—Solution of ammonium butyrate,* 5 mgrm. per liter.

No. 142.—Same solution, 25 mgrm. per liter.

No. 143.—Same solution, 45 mgrm. per liter.

* Prepared from the corresponding pure silver salts.

No. 144.—Solution of ammonium valerianate,* 5 mgrm. per liter.
No. 145.—Same solution, 25 mgrm. per liter.
No. 146.—Same solution, 45 mgrm. per liter.
No. 147.—Solution of tri-methylamine hydrochlorate, 6 mgrm. per liter.
No. 148.—Same solution, 30 mgrm. per liter.
No. 149.—Same solution, 54 mgrm. per liter.
No. 150.—Solution of amylamine† hydrochlorate, 5 mgrm. per liter.
No. 151.—Same solution, 25 mgrm. per liter.
No. 152.—Same solution, 45 mgrm. per liter.
No. 153.—Solution of urea, 6 mgrm. per liter.
No. 154.—Same solution, 30 mgrm. per liter.
No. 155.—Same solution, 54 mgrm. per liter.
No. 156.—Solution of leucine,‡ 4 mgrm. per liter.
No. 157.—Same solution, 20 mgrm. per liter.
No. 158.—Same solution, 36 mgrm. per liter.
No. 159.—Solution of tyrosine,‡ 4 mgrm. per liter.
No. 160.—Same solution, 20 mgrm. per liter.
No. 161.—Same solution, 36 mgrm. per liter.

RESULTS OBTAINED IN THE EXAMINATION OF THE ABOVE SERIES OF WATER SAMPLES.

These results are given in Table X. The following remarks may be made with regard to the entries in some of the columns:

Column 3.—The date given is that of the examination of the water by the different chemical processes; the pathological experiments came a day or so later on account of the time taken to evaporate the water. The marked influence of very high temperature in July and August upon the pathological experiments makes it desirable that this statement should be given; the temperature charts (in column 42) show the dates of the injections. Only the month and day are mentioned; all laboratory work was done in 1881.

Columns 5 and 6.—The turbidity and color are given as observed in a 2-foot tube; in many, indeed most, of the cases in which turbidity and color are here reported, the water appeared quite clear and colorless when looked at in small mass in an ordinary tumbler or beaker of moderate size.

Columns 16 and 18.—The details of the collection of free and albuminoid ammonia are given in Appendix D.

Columns 22 and 23.—The "total inorganic nitrogen" and "previous sewage contamination" have been calculated according to Frankland's instructions and practice.

Column 29.—The figures furnished by Dr. Smart have been corrected by subtraction of oxygen consumed by nitrites or ferrous salts, as has also been done for the results by the Tidy process.

Columns 30 to 38, inclusive.—The dissolved gases are reported as actually found; it is obvious that, in the case of waters artificially prepared with infusions of organic matter, the quantities of gas which have been found in the normal waters (varying with temperature, &c.), cannot be deducted, as has been done in regard to the determinations by the combustion, albuminoid ammonia, and permanganate processes.

Column 39.—The temperature given is that of the room in which the water remained until examined for dissolved gases, and of the time at which the gases were expelled by boiling. This temperature was fairly steady, but naturally varied somewhat during the day and two nights preceding the examination of the water. The temperature of the room in which the gas *measurements* were made was very steady, but was not always or usually the same with that given in this column. Of course the samples of water received from a distance had in many cases been exposed in transit to temperatures differing a good deal from that of the laboratory.

Column 42.—The bodily temperature of the rabbits is given in degrees of the *Fahrenheit scale*, as originally reported by Professor Martin and Dr. Hartwell. In the temperature charts each figure for temperature refers to the line immediately *below;* the dots refer to the times (at even hours approximately) at which observations were made; a cross-mark (×) indicates the time at which the injection was made.

Columns 44 to 46, inclusive.—These contain the conclusions drawn by the several analysts as to the general character of each water, looking only to the results obtained in the separate examinations,§ and applying the rules of interpretation laid down by Frankland, Wanklyn, and Tidy respectively. These conclusions were drawn up at

*The valerianic acid was from amyl alcohol of grain fermentation.
†Mainly at least a salt of the optically inactive base.
‡With a minimum of pure dilute hydrochloric acid to facilitate solution.
§And in the case of the artificially prepared waters without a knowledge of the deductions to be made for the constituents of the normal water; this, however, in most cases, would make little difference. For the permanganate process, the deductions have been made by myself.

my request by the several analysts, each being in ignorance of the history of the water under consideration, and ignorant also of the results obtained by the others.

Column 44 includes remarks based upon the "previous sewage contamination" of Frankland (abbreviated as P. S. C.).

Column 47 gives a similar view of the waters in the light of the biological examination, without any knowledge of, or comparison with, the chemical results. The letters M. and H. refer to Professor Martin and Dr. Hartwell, respectively, as authority for the opinion formed. Professor Martin prepared but two lists, namely, of waters which he considered the biological examination had shown to be probably "dangerous" or "suspicious." Dr. Hartwell attempted to classify *all* the waters as "dangerous," "suspicious," "doubtful," and "harmless," but he considered the classification a very rough one only, the data being in many cases wanting on which to found a positive or strong opinion.

It is to be further noted that, in reporting the results of the chemical examination of the artificially prepared waters (containing infusions, &c.), the constituents of the normal water used for dilution have been subtracted (except the dissolved gases), so as to make the results for different dilutions of the same material easily comparable.

In the case of the solutions of definite chemical substances in Class IX, each days' analyses were accompanied by parallel examinations of the particular samples of distilled water used in preparing that day's solution, and the results reported have had subtracted those (necessarily very small figures) obtained from such distilled water.

In all cases in which more than one determination of the same sort was made, which includes, with one or two accidental exceptions, all the determinations by the combustion process, the mean of the best results has been taken if there were more than two, and if two only, the mean of these, save in one or two exceptional cases in which good grounds existed for rejecting an analysis altogether as vitiated by experimental error.

All weights given represent *parts per million*.

of results obtained.

rmanganate process.	Biological examin tion.
46	47
ubtful purity ..	Suspicious (H) ....
dium purity...	Harmless (H) .....
dium purity...	Doubtful(H); (doub probably based o death of (12iv), bu this may be re ferred to previou injection).

	er on basis of result	
	mo-	Premangar process.
		46
	but es- re- tter	Of doubtful p
	s a er.	Of great orga ity.
	s a m a f.	Of great orga ity.
	ly a m a lean	Of great orga ity.

...ganic matter and of ...

...basis of results obtained.

	Permanganate process.	Biolo
2	46	
	Of great organic purity.	Suspi
	Of great organic purity.	Suspi
	Of medium purity...	Doubt

obtained.

ıte	Biological examination.	Combustion proc
	47	48
------	Suspicious (M.); harmless (H.)	----------
ss of	Suspicious (H).....	----------
ty.	Doubtful (II)	Triplicate deter ations were m The figures fo ganic nitrogen ried by absolu very small, relatively la amounts, sug ing suspicion o complete reduc of nitrates.

of water on ba	
id-ammo-ocess.	
5	—
rage pres-nably from	O
iver water.	C
istern wa-	C

f results obtained.

manganate process.	Biological examination.
46	47
.....	Suspicious (M) suspicious (H).
.....	Harmless (H) .....
t organic pu-	Doubtful (H) .....

of results obtained.

nganate cess.	Biological examination.	Combi
3	47	
rganic pu-	Harmless (H)	Some upon ganic termi leaka coc after was have the meas
.....	Harmless (H)	.....
rganic pu-	Harmless (H)	But o tion and crack dish dupli sible with phur undo ducti was and troge too hi for ca too lo
purity...	Harmless (H)	Sulph fully the r ful w were
rganic pu-	Doubtful (H).....	Organi termi resid had ated of sul Orga deter rately tion

asis of results obtained.

	Permanganate process.	Biolog
	46	
mpure		Harml
f medium purity...		Doubt
f great organic purity.		Doubt

f water c	
id-ammo- ocess.	
5	
ell water ated wit wage.	
ell wate tainte age.	
a well cistern rom a we l.	

ssification of water on basis of results			
Albuminoid-ammonia process.	Permangana process.	Miscellaneous.	
45	46	53	
Suspicious well water	Of medium pur	action alkaline. light deposit of arbonates on boiling.	
Good; well or spring.	Of great organi rity.	ghtly alkaline re- tion.	
Doubtful in character; a well water; no urea.	Of doubtful pur	ht deposit on boil g.	

asis of results obtained.	
Permanganate process.	Biolog
46	
Of great organic purity.	Harml
Of great organic purity.	Doubt
Of great organic purity.	Harm
Of great organic purity.	Susp doul
Of medium purity...	Harn

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on basis of results ob

	Permanganate process.
	46
al	Impure .....
m	Of great organic p rity.
n	Impure .....
..	Of great organic p rity.
). n ie t. is of	Of great organic pu rity.

basis of results obtaine

Permanganate process.
46
Of doubtful purity..
Of great organic purity.
Impure .....

f results obtained.

manganate process.	Biolog
46	
re	Doubtf
re	Suspici
ire	Doubtfu

f water on basis of results obtained.				
id-ammo-ocess.	Permanganate process.	Biological examination.	Com' ogical ex. tion.	
5	46	4	53	Miscellaneous.
probably allow well y under-istern. No present; c matter egetable.	Of great organic purity.	Do	.....	

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probably
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	basis of results
Permangana process.	
	46
Impure	
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Of doubtful pu	

on basis of resul	Permanganate process.
	46
Impure	
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Impure	
Impure	

sis of results

Permanganat
process.

46

Impure .....

Impure .....

Impure .....

is of results obt

Permanganate process.

46

medium purity

f medium purity

mpure .....

ts obtained.		
nate .	Biological examination.	Combustio
	47	48
arity...	Suspicious (H)	Analyses satisfacto to use o acid sulp tion aft proved t rior.
.....	Harmless (H)	Triplicate unsatis from same in No. 75.
.....	Doubtful (H).....	.....
.....	Dangerous (M); dangerous (H).	Nitrogen d tions poor
.....	Dangerous (M); dangerous (H).	.....

s of results obtained.

Permanganate process.	Biological examination.
46	47
great organic purity.	Harmless (H) ----
medium purity...	Suspicious (H) --
ure	Doubtful (H) ---
ure	Dangerous (M); s picous (H).

s of results obtained.

ermanganate process.	Biological exa tion.
46	47
oure	Harmless (H) .
oure	Not found on e classified list H).
oure	Harmless (H) .

xamina-	Combustion process.	Albuminoid-a nia proces
	48	49
(M); sus-).	.....	Alkaline perm nate remain slight excess distillation f buminoid NH
us (M); sus- s (H).	.....	There was a gre haze in the late for free In distilling f buminoid NH the permang was reduce second experi with a dilutio the water (per ganate in ex gave .17.

ts obtained.	
ganate 988.	Bi
16	
m purity ..	Dc
e	D s
pure	Su d

	ults obtained.	
e	Biological examination.	
	47	
c pu-	Suspicious (H)	
purity..	Dangerous (M); dangerous (H).	S
.....	Suspicious (H)	

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rmanganate process.	Biological examination.
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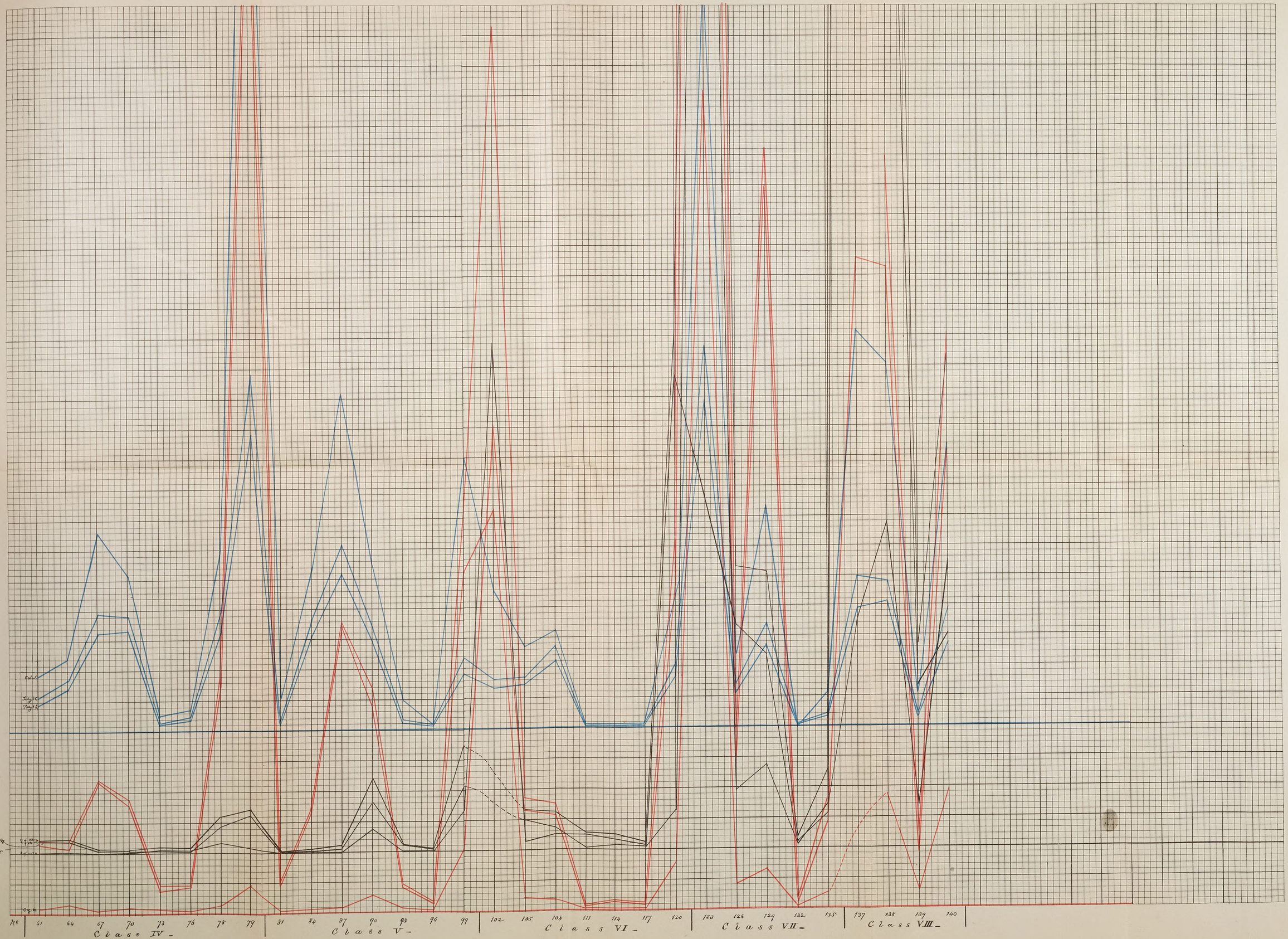
re	Suspicious (H) --
re	Dangerous (M); suspicious (H).
re	Suspicious (H)...

TABLE XX.–GRAPHIC COMPARISON OF RESULTS BY DIFFERENT METHODS–ARTIFICIALLY PREPARED WATERS.



PPENDIX A.—*Details of the re-examination of certain water samples, showing the changes which took place during intervals of ten days.*

No.	Primary examination.		Second, at expiration of ten days.		Third, at expiration of twenty days.		Fourth, at expiration of thirty days.	
	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
1	.12 .025 .005 .000 .150 2 .30	.0125 .005 .0025 .000 .02 2 .04	.0025 .000 .0025 2 .005	.0075 .005 .0025 .000 .015 2 .03				
*2	.08 .025 .005 .110 2 .220	.0375 .02 .01 .0075 .0750 2 .1500	.01 .0025 .000 .0125 2 .0250	.45 .02 .015 .0125 .0925 2 .1850	.01 .0025 .000 .0125 2 .0250	.03 .015 .0125 .005 .0625 2 .1250		
3	.015 .0025 .0175 2 .035	.045 .025 .0125 .005 .0875 2 .175	.015 .0025 .0175 2 .035	.045 .02 .0075 .0025 .075 2 .15	.015 .0025 .0175 2 .035	.04 .02 .015 .0075 .0825 2 .165		
4	—? —? —? 	.14 .105 .0575 .045 .035 .035 .4175 2 .835	.025? .02? .045 2 .09	.19 .10 .05 .04 .04 .04 .46 2 .92				
5	.38 .08 .02 .02 .50 2 1.00	.24 .075 .04 .03 .03 .415 2 .83	.03 .005 .000 .035 2 .07	.16 .08 .04 .03 .03 .34 2 .68				
6	.02 .0075 .0025 .0300 2 .06	.05 .025 .02 .015 .01 .120 2 .24	.03 .015 .0025 .0525 2 .105	.03 .0125 .01 .0075 .005 .0650 2 .13	.03 .015 .005 .050 2 .10	.04 .025 .015 .0075 .0075 .0950 2 .19		

*Nitrites present in primary, absent in second and third.

APPENDIX A.—*Details of the re-examination of certain water samples, &c.*—Continued.

No.	Primary examination.		Second, at expiration of ten days.		Third, at expiration of twenty days.		Fourth, at expiration of thirty days.	
	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
7	.02 .01 .0075 .0375 2 .075	.14 .05 .035 .025 .025 .275 2 .55	.06 .02 .0075 .0025 .09 2 .18	.09 .03 .015 .015 .015 .165 2 .33	.03 .02 .01 .005 .065 2 .13	Nitrites. .08 .0325 .0175 .0175 .0175 .165 2 .33		
8	.03 .02 .015 .01 .075 2 .15	.46 .24 .12 .085 .09 .995 2 1.99	.065 .025 .02 .0175 .1275 2 .255	.56 .28 .15 .11 .11 1.21 2 .242	.17 .04 .0175 .0075 .235 2 .47	.50 .24 .14 .10 .09 1.07 2 2.14	1.40 .30 .055 .015 1.770 2 3.54	.35 .12 .05 .035 .035 .590 2 1.18
9	.02 .015 .01 .045 2 .090	.04 .02 .015 .0125 .0125 .1000 2 .20	.015 .0025 .000 .0175 2 .0350	.04 .015 .0075 .005 .005 .0725 2 .1450				
10	.03 .015 .01 .055 2 .110	.09 .045 .0175 .015 .015 .1825 2 .3650	.03 .015 .01 .055 2 .110	.08 .025 .015 .0125 .0075 .1400 2 .2800				
11	Nitrites present. .19 .035 .0075 .000 .2325 2 .465	.12 .06 .03 .02 .02 .25 2 .50	.015 .005 .000 .020 2 .04	.11 .0475 .025 .02 .0125 .215 2 .43	.015 .005 .000 .02 .04	.11 .05 .03 .02 .0125 .2225 2 .445		
12	Nitrites present. .85 .21 .06 .01 1.13 2 2.26	.36 .17 .085 .055 .05 .720 2 1.44	.03 .0175 .0175 .0650 2 .13	.29 .13 .07 .04 .04 .57 2 1.14	.06 .0175 .01 .0875 2 .175	.30 .12 .06 .04 .03 .55 2 1.10	.03 .01 .005 .045 2 .09	.30 .11 .05 .0325 03 .5225 2 1.045

APPENDIX A.—*Details of the re-examination of certain water samples, &c.*—Continued.

No.	Primary examination.		Second, at expiration of ten days.		Third, at expiration of twenty days.		Fourth, at expiration of thirty days.	
	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
13	.0325 .0075 .0025 .0425 2 .0850	.0325 .0125 .0075 .005 .0575 2 .1150	.025 .01 .0025 .0375 2 .0750	.03 .0125 .01 .005 .0575 2 .1150	.015 .005 .000 .02 2 .04	.025 .01 .01 .01 .055 2 .110	.0075 .005 .0025 .015 2 .030	.0275 .015 .01 .01 .0625 2 .1250
14	.015 .005 .02 2 .04	.0325 .015 .015 .015 .0925 2 .185	.015 .005 .02 2 .04	.04 .02 .015 .01 .01 .095 2 .190	.02 .005 .025 2 .05	.04 .02 .015 .01 .01 .095 2 .190		
15	—? —? —? —? —? —? —? —?	.04 .02 .01 .005 .075 2 .15	—? —? —? —?	.075 .0325 .02 .015 .0125 .155 2 .31	—? —? —? —?	.13 .08 .05 .03 .0175 .3075 2 .615	—? —? —?	.16 .095 .055 .035 .03 .375 2 .75
16	.015 .005 .020 2 .04	.09 .05 .025 .025 .025 .215 2 .43	.07 .015 .01 .095 2 .19	.08 .035 .015 .0125 .01 .1525 2 .305	.01 .0025 .0125 2 .025	.06 .0275 .0075 .005 .005 .1050 2 .21		
17	.03 .015 .015 .060 2 .12	.30 .19 .10 .08 .07 .74 2 .148	.13 .0225 .01 .1625 2 .325	.34 .16 .10 .07 .07 .74 2 1.48	.18 .05 .0125 .2425 2 .485	.36 .15 .08 .055 .05 .695 2 .139		
18	.0425 .0125 .0025 .0575 2 .115	.08 .04 .02 .015 .01 .165 2 .33	.0325 .015 .005 .0525 2 .105	.0525 .02 .015 .01 .0075 .105 2 .21	.02 .005 .0025 .0275 2 .055	.05 .02 .02 .0125 .01 .1125 2 .225	.02 .005 .0025 .0275 2 .055	.065 .0325 .03 .025 .02 .1725 2 .345

APPENDIX A.—*Details of the re-examination of certain water samples, &c.*—Continued.

No.	Primary examination.		Second, at expiration of ten days.		Third, at expiration of twenty days.		Fourth, at expiration of thirty days.	
	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
19	.52 .12 .045 .03 .03	.187 .38 .12 .08	1.12 .40 .09 .05 .03	1.20 .44 .16 .09	.48 .12 .055 .035 .03	Nitrites. 1.44 .44 .24 .13		
		2.45		1.89		2.25		
	.745 2	2	1.69 2	2	.72 2	2		
		4.90		3.78		4.50		
	.149		3.38		1.44			
20	.045 .01 .0075 .0075	.0175 .01 .005 .0025	.005 .0025 .000	.015 .0075 .0025 .000				
			0.0075					
	.0700 2	.0350 2	2	.250 2				
			.015					
	.14	.07		.05				
21	.065 .02 .005	.05 .025 .0175 .0125	.0175 .015 .01	.55 .0275 .025 .015	.0075 .0025 .0100	.04 .0125 .0075 .005		
	.090 2	.0125	.0425 2	.0125	2	.005		
		.1175		.1350	.02	.0700		
	.18	2	.085	2		2		
		.235		.27		.14		
22	.14 .04 .01	.0725 .0425 .03 .02	.005 .000 .005	.055 .02 .015 .01	.005 .000 .005	.05 .02 .015 .01		
	.19 2	.01	2	.01	2	.01		
		.1750	.01	.110	.01	.105		
	.38	2		2		2		
		.35		.22		.21		
23	.64 .14 .03 .005	.16 .06 .03 .02 .015	.01 .0025 .0125 2	.07 .04 .015 .0075 .0025	.015 .005 .02 2	.075 .035 .015 .0125 .01		
	.815 2	.285	.025	.1350	.04	.1475		
	1.63	2		2		2		
		.57		.27		.295		
24	1.45 .32 .05 .01	.36 .10 .055 .04 .04	1.66 .40 .07 .01	.18 .0675 .0275 .015 .015	.08 .0175 .000 .0975	Nitrites. .10 .045 .02 .01 .005	.035 .0075 .000 .0425	Nitrites. .07 .025 .01 .0025 .1075
	1.83 2	.595	2.14 2	.305	2	.18	2	2
		2		2	.195	2	.085	.215
	3.66	1.19	4.28	.61		.36		

APPENDIX A.—*Details of the re-examination of certain water samples, &c.*—Continued.

No.	Primary examination.		Second, at expiration of ten days.		Third, at expiration of twenty days.		Fourth, at expiration of thirty days.	
	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
25	.12 .03 .005 .155 2 .31	.09 .045 .02 .01 .01 .175 2 .35	.035 .005 .0025 .0425 2 .085	.05 .015 .01 .005 .005 .085 2 .17				
26	.40 .08 .02 .005 .505 2 1.01	.075 .035 .015 .01 .135 2 .27	.34 .07 .0125 .005 .4275 2 .855	.05 .02 .01 .005 .005 .090 2 .18				
27	.64 .16 .03 .0075 .8375 2 1.675	.40 .16 .08 .07 .71 2 1.42	1.12 .22 .04 .01 1.39 2 2.78	.24 .07 .03 .03 .37 2 .74				
28	1.76 .56 .12 .03 .02 2.49 2 4.98	2.00 .81 .40 .28 3.49 2 6.98	5.00 1.25 .815 .045 .0175 6.4625 2 12.925	1.10 .56 .28 .18 2.12 2 4.24				
29	2.10 .48 .12 .03 2.73 2 5.46	.44 .14 .07 .055 .055 .76 2 1.52	3.70 .90 .14 .03 4.77 2 9.54	.20 .065 .035 .025 .025 .35 2 .70	.75 .18 .03 .015 .975 2 1.95	Nitrites. .12 .035 .015 .015 .015 .200 2 .40		
30	2.28 .40 .105 .03 .03 2.845 2 5.69	2.66 .87 .40 .24 4.17 2 8.34	4.50 .56 .18 .045 .03 5.315 2 10.63	2.25 .75 .40 .28 3.68 2 7.36	4.75 .65 .18 .06 .04 5.68 2 11.36	2.00 .75 .28 .20 3.23 2 6.46	3.25 .75 .15 .04 .03 4.22 2 8.44	1.69 .70 .40 .30 3.09 2 6.18

APPENDIX A.—*Details of the re-examination of certain water samples, &c.*—Continued.

No.	Primary examination.		Second, at expiration of ten days.		Third, at expiration of twenty days.		Fourth, at expiration of thirty days.	
	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
31	56.80 6.77 .62 .10 .06 64.35 2 128.70	2.00 .90 .42 3.32 2 6.64	42.00 11.50 1.80 .35 .085 .06 55.795 2 111.59	Nitrites. 1.68 .67 .40 2.75 2 5.50				

APPENDIX B.—*Details of experiments on distillation and condensation of known quantities of ammonia.*

	First condenser.	Second condenser.
.05 mgrm	.0325 .005 .0025 .000 .0400=20 per cent. loss.	.035 .010 .000 .045=10 per cent. loss.
.10 mgrm	.07 .015 .0025 .000 .0875=12.5 per cent. loss.	.0725 .0125 .0025 .000 .0875=12.5 per cent. loss.
.20 mgrm	.145 .0325 .0075 .000 .1850=7.5 per cent loss.	.15 .03 .005 .000 .185=7.5 per cent. loss.
.25 mgrm	.175 .05 .01 .0025 .000 .2375=5 per cent. loss.	.18 .04 .0125 .0025 .000 .2350=6 per cent. loss.
.30 mgrm	.22 .045 .01 .000 .275=8.3 per cent. loss.	.21 .05 .01 .000 .27=10 per cent. loss.

APPENDIX B.—*Details of experiments on dissillation and condensation, &c.*—Continued.

	FIRST CONDENSER.	SECOND CONDENSER.
.50 mgrm	.37	.38
	.085	.09
	.015	.0175
	.0025	.0025
	.000	.000
	.4725=5.5 per cent. loss.	.4900 = 2 per cent. loss.
.75 mgrm	.57	.59
	.13	.12
	.02	.0125
	.005	.0025
	.000	.000
	.725=3.3 per cent. loss.	.7250 = 3.3 per cent. loss.
1.0 mgrm	.70	.70
	.18	.175
	.0325	.0325
	.0075	.0075
	.000	.000
	.9200=8 per cent. loss.	.9150 = 8.5 per cent. loss.
1.5 mgrms	1.03	1.08
	.30	.26
	.0475	.0475
	.01	.0075
	.0025	.000
	1.3900=7.3 per cent. loss.	1.3950 = 7 per cent. loss.
2.0 mgrms	1.37	1.50
	.44	.32
	.07	.075
	.015	.0075
	.0025	.000
	1.8975=5.1 per cent. loss.	1.9025 = 4.9 per cent. loss.
2.5 mgrms	1.875	1.58
	.50	.55
	.08	.12
	.01	.02
	.0025	.0025
	2.4675=1.3 per cent loss.	2.2725 = 9.1 per cent. loss.
3.5 mgrms	2.12	2.80
	.82	.50
	.28	.115
	.075	.015
	.02	.015
	.0025	.000
	3.3175=5.2 per cent. loss.	3.430 = 2 per cent. loss.

APPENDIX B.—*Details of experiments on distillation and condensation, &c.*—Continued.

	FIRST CONDENSER.	SECOND CONDENSER.
5.0 mgrms	3.45	3.50
	.76	.85
	.14	.18
	.02	.03
	.0025	.005
	4.3725=12.5 per cent. loss.	4.565 = 8.7 per cent. loss.

Repeated in first condenser but with lower flame.

5.0 mgrms	3.60
	.80
	.18
	.04
	.01
	.000
	4.63 = 7.4 per cent. loss.

APPENDIX C.—*Details of collection of ammonia yielded by nitrogenous organic substances of definite composition, treated by albuminoid ammonia process.*

Potassium cyanide:

3 mgrms. gave—	6 mgrms. gave—	
.075	.15	
.04	.08	
.04	.075	
.03	.055	Here 150 c. c. of pure water added to continue experiment.
.03		
.215 +	.05	
	.05	
	.05	
Ending of process indefinite.	.51 +	

Silver and potassium cyanide:

10 mgrms. gave—
.075
.06
.06
.06
.07
.08

.405 +

Ending of process indefinite and action apparently increasing for last two measures, probably from lowering of lamp flame.

Prussian blue:

20 mgrms. gave—
.025
.015
.01
.01
.015
.015

.090 +

APPENDIX C.—*Details of collection of ammonia, &c.*—Continued.

Sodium nitro-prusside:

5 mgrms. gave—	5 mgrms. gave—
.105	.095
.09	.08
.085	.07
.075	.06
.07	.04
.065	.055
.49+	.40+

Potassium iso-cyanate:

100 mgrms. gave—
.095
.09
.08
.07
.055
.055
.445+

Action slow and unfinished.

Cyanuric acid:

100 mgrms. gave—	
.025	
.045	
.055	
.09	Residue permitted to stand for twenty-four hours, and distillation then resumed.
.13	
.13	
.13	
.605+	

Remarkable for increased evolution of NH_3, as action progressed.

Nitro-mannite:

10 mgrms. gave—	100 mgrms. gave—
.02	.07
.005	.02
.025	.01
	.005
	.105

The definite ending in each case seems to point to the presence of a minute amount of some impurity, the nitro-mannite itself not being acted on.

Tri-ethylamine hydrochlorate:

$2\frac{1}{2}$ mgrms. gave—	5 mgrms. gave—
.22	.42
.05	.08
.015	.015
.000	.000
.285	.515

Leucine:

10 mgrms. gave—	10 mgrms. gave—	10 mgrms. gave—
.66	.72	.76
.22	.15	.18
.06	.03	.03
.015	.01	.01
.955	.91	.98

APPENDIX C.—*Details of collection of ammonia, &c.*—Continued.

Oxamide:

5 mgrms. gave—	10 mgrms. gave—
1.10	2.34
.26	.40
.06	.08
.02	.015
.015	.01
1.455	2.845

Succinimide:

2 mgrms. gave—	5 mgrms. gave—	10 mgrms. gave—
.16	.34	.60
.065	.20	.36
.02	.055	.16
.005	.015	.045
.000	.000	.01
.250	.610	1.175

Succinamide:

5 mgrms. gave—	10 mgrms. gave—	10 mgrms. gave—
1.00	1.75	1.95
.30	.65	.48
.06	.18	.14
.02	.04	.03
.005	.01	.01
1.385	2.63	2.61

Urea (from urine):

5 mgrms. gave—	10 mgrms. gave—
.105	.255
.11	.22
.11	.20
.11	.19
.095	.19
.105	.19
.635	1.245

Ending of experiment quite indefinite.

Urea (from ammonium cyanate):

5 mgrms. gave—	10 mgrms. gave—
.090	.16
.095	.19
.10	.20
.10	.20
.11	.20
.11	.20
.605	1.15

Ending of experiment quite indefinite.

Thio-carbamide:

2 mgrms. gave—	5 mgrms. gave—	10 mgrms. gave—
.21	.60	1.15
.05	.09	.23
.025	.035	.09
.02	.025	.055
		.04
.305	.750	1.565

APPENDIX C.—*Details of collection of ammonia, &c.*—Continued.

Alloxan:

10 mgrms. gave—	10 mgrms. gave—
.40	.40
.10	.14
.08	.06
.075	.06
.06	.06
.06	.06
.775	.78

Ending of experiment indefinite.

Parabanic acid:

10 mgrms. gave—
.11
.055
.04
.045
.055
.10
.405

Action unfinished. Increased evolution of ammonia, as contents of retort became concentrated.

Asparagine:

2 mgrms. gave—	3 mgrms. gave—	4 mgrms. gave—
.34	(In 100 c. c.) .60	(In 100 c. c.) .80
.08	.03	.04
.02	.00	.015
.00	.63	.855
.44		

Substance breaks up readily, and ending of reaction is well defined.

Para-nitrotoluene:

Gave no ammonia, but distilled over with the vapor of water, giving strong odor to distillate.

Para-nitraniline:

5 mgrms. gave—	10 mgrms. gave—
.20	.44
.09	.13
.035	.04
.015	.02
.005	.01
.005	.005
.350	.645

Thio-carbanilide:

10 mgrms. gave—
.25
.085
.04
.04
.035
.05
.50

Ending indefinite.

APPENDIX C.—*Details of collection of ammonia, &c.*—Continued.

Rosaniline hydrochlorate:

5 mgrms. gave—	10 mgrms. gave—	10 mgrms. gave—
.07	.105	.36
.03	.065	.07
.02	.07	.03
.025	.07	.02
.145	.310	.48

The difference between these results was partly due to particles of the solid substance being cast up by the boiling upon the inside surface of the retort, whence they could not be washed down again. The highest result, the last, was obtained by introducing the substance already in solution. The ending in each case, however, is so indefinite that it is obvious the action of the alkaline permanganate was by no means exhausted.

Azobenzene:

Carried over with vapor of water, but yielded no ammonia.

Tropæoline 00:

10 mgrms. gave—	20 mgrms. gave—
.19	.34
.055	.085
.02	.035
.005	.01
.270	.470

These results look like a definite ending of the action, but the Table VII shows how far the nitrogen is from exhaustion, or from removal of any rational fraction as ammonia.

Benzamide:

10 mgrms. gave—
.36
.28
.26
.14
.055
.02
1.115

The rapid falling off of the ammonia in the last two measures seems to indicate the approach of a definite ending.

Indigotine:

10 mgrms. gave—	10 mgrms. gave—	10 mgrms. gave—
.36	.36	.36
.135	.12	.13
.065	.06	.065
.035	.03	.035
.025	.015	.02
.02	.585	.610
.64		

Codeine:

2 mgrms. gave—	5 mgrms. gave—	5 mgrms. gave—
.05	.12	.12
.025	.05	.045
.015	.03	.025
.01	.015	.015
.10	.01	.005
	.225	.210

APPENDIX C.—*Details of collection of ammonia, &c.*—Continued.

Quinine sulphate:

7 mgrms. gave—	7 mgrms. gave—
.14	.13
.07	.09
.035	.04
.025	.025
.015	.020
.020	
.285	.325

Ending ill defined.

Cinchonine sulphate:

2 mgrms. gave—	5 mgrms. gave—
.04	.09
.025	.065
.015	.03
.01	.025
	.02
	.02
.09	.25

Ending ill defined.

Strychnine sulphate:

5 mgrms. gave—	5 mgrms. gave—	8 mgrms. gave—	8 mgrms. gave—
.09	.11	.13	.12
.06	.06	.08	.10
.03	.03	.05	.05
.02	.01	.04	.04
.01	.01	.02.	025
			.020
.21	.22	.32	.020
			.375

The process is without definite ending. This is especially shown by comparing the last experiment, in which seven measures of the distillate were collected instead of five, with the three others.

Brucine:

2 mgrms. gave—	5 mgrms. gave—
.05	.15
.025	.07
.015	.03
.005	.02
.095	.27

Ending rather doubtful.

"Atropine":

2 mgrms. gave—	5 mgrms. gave—
.05	.15
.03	.05
.015	.02
.01	.015
.105	.235

Ending rather doubtful. After standing for 68 hours the residues were further distilled, giving for the 2 mgrms. .002, and for the 5 mgrms. .005 more NH_3.

Veratrine:

2 mgrms. gave—	5 mgrms. gave—
.04	.10
.015	.035
.01	.02
.005	.005
.07	.16

APPENDIX C.—*Details of collection of ammonia, &c.*—Continued.

Piperine:

5 mgrms. gave—	7.5 mgrms. gave—	10 mgrms. gave—
.18	.20	.18
.06	.07	.06
.04	.06	.06
	.05	.06
.28+	.04	.05
		.05
	.42+	.05
		.51+

The continuance of comparatively large amounts of NH_3 in the last measures of distillate collected is remarkable in view of the near approach made to complete exhaustion of the nitrogen (see Table VII). In the experiment with 10 mgrms., 600 c. c. of water instead of 500 c. c. was used, so as to get an additional amount of distillate. The effect of the dilution seems to have been to render the reaction slower.

Theine (from tea):

2 mgrms. gave—	4 mgrms. gave—	4 mgrms. gave—	5 mgrms. gave—	10 mgrms. gave—
.13	.15	.22	.30	.32
.05	.20	.22	.16	.36
.035	.14	.11	.08	.26
.02	.08	.035	.04	.16
.01	.045	.020	.02	.09
	.030	.020		.05
.245	.030	.015	.60	
				1.24
	.675	.640		

The two experiments with 4 mgrms. each were varied, the one by commencing with a larger quantity of water, the other by using a smaller flame, so that a longer time might be taken for the distillation. In two of the above experiments it is remarkable that the second measure of distillate contained more ammonia than the first.

Theine (from coffee):

2 mgrms. gave—	5 mgrms. gave—	5 mgrms. gave—
.12	.30	.31
.11	.25	.22
.05	.09	.11
.03	.04	.045
		.03
.31	.68	
		.715

Glycocholic acid:

25 mgrms. gave—
.08
.14
.14
.09
.07
.06
.58+

Action unfinished. More NH_3 in second measure than in first.

Albumen (from blood):

5 mgrms. gave—	5 mgrms. gave—
.160	.20
.085	.095
.045	.050
.025	.035
.015	.030
.330+	.410+

The second experiment was made slowly, with low flame; hence the larger yield of ammonia.

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia in examination of main series of water samples.*

No. 1.

Free ammonia:		Albuminoid ammonia:	
	.02		.03
	.0025		.0125
			.01
	.0225		.01
	2		.01
	.0450		.0725
			2
			.145

No. 2.

Free ammonia:		Albuminoid ammonia:	
	.12		.0125
	.025		.005
	.005		.0025
	.000		.000
	.15		.02
	2		2
	.30		.04

No. 3.

Free ammonia:		Albuminoid ammonia:	
	.32		.01
	.085		.005
	.005		.0025
	.000		.000
	.41		.0175
	2		2
	.82		.035

No. 4.

Free ammonia:		Albuminoid ammonia:	
	.03		.075
	.005		.0325
	.000		.045
			.01
	.035		.0075
	2		.1400
	.07		2
			.28

No. 5.

Free ammonia:		Albuminoid ammonia:	
	.01		.0075
	.000		.0025
			.000
	.01		.01
	2		2
	.02		.02

No. 6.

Free ammonia:		Albuminoid ammonia:	
	.035		.028
	.01		.012
	.00		.005
			.005
	.045		.05
	2		2
	.090		.10

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 7.

Free ammonia:		Albuminoid ammonia:	
	.02		.02
	.005		.0075
	.000		.0025
			.000
	.025		.03
	2		2
	.05		.06

No. 8.

Free ammonia:		Albuminoid ammonia:	
	.07		.04
	.02		.02
	.0025		.0125
			.01
	.0925		.0825
	2		2
	.185		.165

No. 9.

Free ammonia:		Albuminoid ammonia:	
	.0075		.007
	.000		.003
			.000
	.0075		.01
	2		2
	.015		.02

No. 10.

Free ammonia:		Albuminoid ammonia:	
	.01		.0125
	.000		.005
			.0028
			.000
	.01		.02
	2		2
	.02		.04

No. 11.

Free ammonia:		Albuminoid ammonia:	
	.025		.075
	.005		.0275
	.005		.01
			.0075
			.0075
	.035		.1275
	2		2
	.07		.255

No. 12.

Free ammonia:		Albuminoid ammonia:	
	.0075		.04
	.0025		.02
			.01
			.005
	.01		.075
	2		2
	.02		.15

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 13.

Free ammonia:		Albuminoid ammonia:	
	.005		.025
	.000		.015
			.01
	.005		.005
	2		
			.055
	.01		2
			.11

No. 14.

Free ammonia:		Albuminoid ammonia:	
	.04		.06
	.01		.0225
	.0025		.01
			.0125
	.0525		.105
	2		2
	.105		.210+

No. 15.

Free ammonia:		Albuminoid ammonia:	
	.0175		.035
	.005		.015
	.0025		.0075
			.005
	.025		.0625
	2		2
	.05		.125

(Examination made in triplicate. These figures represent one set of results; the mean of all is given in Table X.)

No. 16.

Free ammonia:		Albuminoid ammonia:	
	.02		.035
	.005		.0175
	.0025		.0125
			.01
	.0275		.075
	2		2
	.055		.150

No. 17.

Free ammonia:		Albuminoid ammonia:	
	.015		.09
	.0025		.0375
	.0025		.015
			.01
	.02		.01
	2		.1625
	.04		2
			.325

No. 18.

Free ammonia:		Albuminoid ammonia:	
	.015		.07
	.01		.0275
	.01		.015
			.01
	.035		.0075
	2		.13
	.07		2
			.26

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 19.

Free ammonia: .04	Albuminoid ammonia: .0275
.0075	.01
.000	.005
	.0025
.0475	.045
2	2
.095	.09

No. 20.

Free ammonia: .045	Albuminoid ammonia: .03
.015	.02
.005	.012
.000	.01
.065	.072
2	2
.130	.144

No. 21.

Free ammonia: .0125	Albuminoid ammonia: .01
.0025	.0025
.015	.0125
2	2
.03	.025

No. 22.

Free ammonia: .045	Albuminoid ammonia: .075
.0125	.025
.000	.015
	.01
.0575	.125
2	2
.115	.250+

No. 23.

Free ammonia: .015	Albuminoid ammonia: .035
.0025	.02
	.01
.0175	.005
2	.07
.035	2
	.14

No. 24.

Free ammonia: .025	Albuminoid ammonia: .015
.008	.0075
.002	.0075
	.005
.035	.035
2	2
.07	.07+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 25.

Free ammonia:		Albuminoid ammonia:	
	.005		.0125
	.000		.005
			.005
	.005		.0225
	2		2
	.01		.045

No. 26.

Free ammonia:		Albuminoid ammonia:	
	.01		.06
	.0025		.035
			.0175
	.0125		.01
	2		.0075
	.025		.13
			2
			.26

No. 27.

Free ammonia:		Albuminoid ammonia:	
	.07		.02
	.02		.01
	.005		.005
	.000		.0025
	.095		.0375
	2		2
	.19		.075

No. 28.

Free ammonia:		Albuminoid ammonia:	
	.0225		.02
	.01		.015
	.0025		.01
			.005
	.035		.05
	2		2
	.07		.10

No. 29.

Free ammonia;		Albuminoid ammonia:	
	.06		.02
	.015		.015
	.000		.01
			.005
	.075		.05
	2		2
	.15		.10

No. 30.

Free ammonia:		Albuminoid ammonia:	
	.08		.0375
	.025		.02
	.005		.01
			.0075
	.11		.075
	2		2
	.22		.15

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 31.

Free ammonia:		Albuminoid ammonia:	
	.05		.055
	.015		.03
	.005		.015
			.01
			.01
	.07		.12
	2		2
	.14		.24+

No. 32.

(In one of the triplicate determinations.)

Free ammonia:		Albuminoid ammonia:	
	.01		.025
	.0075		.01
	.0025		.005
	.02		.04
	2		2
	.04		.08

No. 33.

Free ammonia:		Albuminoid ammonia:	
	.05		.07
	.015		.035
	.0075		.0175
	.0725		.1225
	2		2
	.145		.245

No. 34.

Free ammonia:		Albuminoid ammonia:	
	.09		.025
	.02		.01
	.005		.0075
			.005
	.115		.0475
	2		2
	.23		.095

No. 35.

(In one of the triplicate determinations.)

Free ammonia:		Albuminoid ammonia:	
	.15		.015
	.025		.01
	.0025		.0025
			.0025
	.1775		.03
	2		2
	.355		.06

No. 36.

Free ammonia:		Albuminoid ammonia:	
	.05		.03
	.0075		.007
	.0025		.004
			.002
	.06		.043
	2		2
	.12		.086

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 37.

Free ammonia:	.0075	Albuminoid ammonia:	.0175
	.000		.01
	.0075		.005
	2		.0025
	.015		.035
			2
			.07

No. 38.

Free ammonia:	.03	Albuminoid ammonia:	.0375
	.01		.015
	.00		.01
	.04		.0075
	2		.005
	.08		.075
			2
			.150

No. 39.

Free ammonia:	.005	Albuminoid ammonia:	.01
	.000		.005
	.005		.000
	2		.015
	.01		2
			.03

No. 40.

Free ammonia:	.01	Albuminoid ammonia:	.03
	.0025		.015
	.000		.01
	.0125		.005
	2		.06
	.025		2
			.12

No. 41.

Free ammonia:	.01	Albuminoid ammonia:	.0075
	.0025		.0025
	.000		.000
	.0125		.01
	2		2
	.025		.02

No. 42.

Free ammonia:	.06	Albuminoid ammonia:	.015
	.01		.006
	.00		.002
	.07		.023
	2		2
	.14		.046

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 43.

Free ammonia :		Albuminoid ammonia :	
	.0125		.015
	.0025		.008
			.002
	.015		.025
	2		2
	.03		.05

No. 44.

Free ammonia :		Albuminoid ammonia :	
	.02		.035
	.005		.0125
	.000		.01
			.005
	.025		.0625
	2		2
	.05		.125

No. 45.

Free ammonia :		Albuminoid ammonia :	
	.02		.08
	.00		.045
			.025
	.02		.025
	2		.01
	.04		.185
			2
			.37

No. 46.

Free ammonia :		Albuminoid ammonia :	
	—?		.14
	—?		.105
			.0575
	—?		.045
			.035
			.035
			.4175
			2
			.835

No. 47.

Free ammonia :		Albuminoid ammonia :	
	.015		.045
	.0025		.025
			.0125
	.0175		.005
	2		.0875
	.035		2
			.175

No. 48.

Free ammonia :		Albuminoid ammonia :	
	.0175		.01
	.0025		.005
	.000		.0025
	.02		.0175
	2		2
	.04		.035

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 49.

Free ammonia :	.025	Albuminoid ammonia :	.04
	.01		.02
	.0025		.01
			.005
	.0375		.075
	2		2
	.075		.150

No. 50.

Free ammonia :	.01	Albuminoid ammonia :	.025
	.0025		.01
			.005
	.0125		.000
	2		.04
	.025		2
			.08

No. 51.

Free ammonia :	.025	Albuminoid ammonia :	.025
	.01		.0125
	.0025		.0075
			.0025
	.0375		.0475
	2		2
	.075		.095

No. 52.

Free ammonia :	.02	Albuminoid ammonia :	.18
	.0075		.07
	.0025		.03
			.02
	.03		.015
	2		.315
	.06		2
			.63+

No. 53.

Free ammonia :	.0225	Albuminoid ammonia :	.035
	.0125		.02
	.005		.0125
			.01
	.040		.0775
	2		2
	.080		.155

No. 54.

Free ammonia :	.015	Albuminoid ammonia :	.07
	.01		.025
	.01		.015
			.0125
	.035		.0125
	2		.135
	.07		2
			.27+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 55.

Free ammonia :		Albuminoid ammonia :	
	.01		.045
	.0025		.02
			.01
	.0125		.005
	2		.0025
	.025		.0825
			2
			.165

No. 56.

Free ammonia :		Albuminoid ammonia :	
	.38		.24
	.08		.075
	.02		.04
	.02		.03
			.03
	.50		.415
	2		2
	1.00		.83

No. 57.

Free ammonia :		Albuminoid ammonia :	
	.26		.18
	.065		.07
	.0125		.035
	.005		.02
			.02
	.3425		.325
	2		2
	.685		.65+

No. 58.

Free ammonia :		Albuminoid ammonia :	
	.015		.025
	.005		.015
	.000		.01
			.005
	.02		.000
	2		
	.04		.055
			2
			.11

No. 59.

Free ammonia :		Albuminoid ammonia :	
	.04		.075
	.01		.035
	.000		.015
			.0125
	.05		.1375
	2		2
	.10		.275+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 60.

For this and all the other artificially-prepared waters the record of ammonia obtained in successive measures of distillate must, of course, be given for the waters as a whole, *i. e.*, without subtraction of the amounts due to the normal water itself.

Free ammonia:		Albuminoid ammonia:	
	.02		.05
	.0075		.025
	.0025		.02
	.03		.015
	2		.01
	.06?		.12
			2
			.24+

No. 61.

Free ammonia:		Albuminoid ammonia:	
	.02		.14
	.01		.05
	.0075		.035
	.0375		.025
	2		.025
	.075		.275
			2
			.55+

(A repetition as far as first three measures gave exactly the same results.)

No. 62.

Free ammonia:		Albuminoid ammonia:	
	.03		.46
	.02		.24
	.015		.12
	.01		.085
	.075		.09
	2		1.99+
	.15		

No. 63.

Free ammonia:		Albuminoid ammonia:	
	.015		.065
	.005		.035
	.000		.020
	.02		.12
	2		2
	.04		.24

No. 64.

Free ammonia:		Albuminoid ammonia:	
	.02		.19
	.015		.09
	.005		.05
	.000		.035
	.04		.365
	2		2
	.08		.73+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 65.

Free ammonia:		Albuminoid ammonia:	
	.14		.48
	.045		.26
	.015		.11
	.005		.08
	.205		.045
	2		.975
	.41		2
			1.95

No. 66.

Free ammonia:		Albuminoid ammonia:	
	.01		.025
	.0025		.015
	.0125		.0075
	2		.005
	.025		.0525
			2
			.105+

No. 67.

Free ammonia:		Albuminoid ammonia:	
	.01		.06
	.005		.035
	.015		.02
	2		.01
	.03		.01
			.135
			2
			.27+

No. 68.

Free ammonia:		Albuminoid ammonia:	
	.03		.11
	.025		.05
	.02		.02
	.015		.015
	.09		.015
	2		.21
	.18		2
			.42+

No. 69.

Free ammonia:		Albuminoid ammonia:	
	.015		.035
	.005		.015
	.0025		.0075
	.0225		.005
	2		.005
	.045		.0675
			2
			.135

No. 70.

Free ammonia:		Albuminoid ammonia:	
	.02		.04
	.015		.02
	.01		.015
	.045		.0125
	2		.0125
	.09		.10
			2
			.20

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 71.

Free ammonia:		Albuminoid ammonia:	
	.03		.09
	.015		.045
	.01		.0175
			.015
	.055		.015
	2		
			.1825
	.11		2
			.365+

No. 72.

Free ammonia:		Albuminoid ammonia:	
	.095		.04
	.0225		.02
	.0075		.0125
			.01
	.125		.0825
	2		2
	.25		.165

No. 73.

Free ammonia:		Albuminoid ammonia:	
	.19		.12
	.035		.06
	.0075		.03
	.000		.02
			.02
	.2325		.25
	2		2
	.465		.50+

No. 74.

Free ammonia:		Albuminoid ammonia:	
	.85		.36
	.21		.17
	.06		.085
	.01		.055
			.05
	1.13		.720
	2		2
	2.26		1.44+

No. 75.

Free ammonia:		Albuminoid ammonia:	
	.0325		.0325
	.0075		.0125
	.0025		.0075
			.005
	.0425		.0575
	2		2
	.085		.115

No. 76.

Free ammonia:		Albuminoid ammonia:	
	.04		.04
	.015		.015
	.0025		.01
			.005
	.0575		.07
	2		2
	.115		.14

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 77.

Free ammonia:		Albuminoid ammonia:	
	.22		.11
	.05		.04
	.025		.0175
	.015		.015
	.31		.1825
	2		2
	.62		.365+

No. 78.

Free ammonia:		Albumnioid ammonia:	
	.11		.23
	.0325		.09
	.015		.05
	.01		.035
	.1675		.04
	2		.445
	.335		2
			.89+

No. 79.

Free ammonia:		Albuminoid ammonia:	
	.04		.14
	.03		.065
	.015		.04
	.085		.035
	2		.025
	.17		.305
			2
			.61+

Same (with 125 c. c. of alkaline permanganate).

	.38
	.14
	.055
	.03
	.025
	.63
	2
	1.26

No. 80.

Free ammonia:		Albuminoid ammonia:	
	.000		.015
	.000		.01
	.000		.005
			.0025
			.0325
			2
			.065

No. 81.

Free ammonia:		Albuminoid ammonia:	
	.004		.025
	.001		.0125
	.005		.01
	2		.0475
	.01		2
			.095

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 82.

Free ammonia: .01
.0025
.0125
2
.025

Albuminoid ammonia: .045
.0275
.015
.01
.0975
2
.195+

No. 83.

Free ammonia: .015
.0025
.000
.0175
2
.035

Albuminoid ammonia: .04
.0175
.0125
.01
.08
2
.16

No. 84.

Free ammonia: .015
.005
.02
2
.04?

Albuminoid ammonia: .0325
.015
.015
.015
.0775
2
.155+

No. 85.

Free ammonia: ? (a trace present, but cloudiness prevented even approximate determination.)

Albuminoid ammonia: .04
.02
.01
.005
.075
2
.15+

No. 86.

Free ammonia: .015
.0025
.0175
2
.035

Albuminoid ammonia: .035
.01
.005
.0025
.000
.0525
2
.105

No. 87.

Free ammonia: .01
.000
.01
2
.02

Albuminoid ammonia: .115
.07
.0375
.0225
.0125
.2575
2
.515+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 88.

Free ammonia: .01
.00
.00
.01
2
.02

Albuminoid ammonia: .045
.01
.000
.055
2
.11

All the permanganate having been reduced in this experiment, a second was made upon a dilution of the water (1 + 4 = 5; = 20 per cent.) with the following result:

.055
.0225
.01
.0075
.005
.10
2
.20

No. 89.

In one of the triplicate determinations—

Free ammonia: .11
.03
.01
.00
.15
2
.30

Albuminoid ammonia: .16
.05
.03
.025
.265
2
.53+

No. 90.

Free ammonia: .04
.015
.01
.005
.07
2
.14

Albuminoid ammonia: .48
.24
.16
.11
.99
2
1.98

No. 91.

Free ammonia: 1.65
.40
.09
.05
.015
2.205
2
4.41

Albuminoid ammonia: 1.17
.56
.24
1.97
2
3.94+

All the permanganate of the regular charge being reduced, a second distillation was made with a double charge (=100 c. c). The result was:

2.61
.91
.42
3.94
2
7.88+

Leaving now permanganate in excess.

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 92.

Free ammonia: .01	Albuminoid ammonia: .06
.0025	.03
.000	.015
	.015
	.015
.0125	.135
2	2
.025	.27+

No. 93.

Free ammonia: .015	Albuminoid ammonia: .09
.005	.05
	.025
	.025
	.025
.02	.215
2	2
.04	.43+

No. 94.

Free ammonia: .03	Albuminoid ammonia: .30
.015	.19
.015	.10
	.08
	.07
.06	.74
2	2
.12	1.48+

No. 95.

In one of the triplicate determinations—

Free ammonia: .06	Albumnioid ammonia: .0525
.02	.02
.005	.0125
	.01
	.005
.085	.10
2	2
.170	.20

No. 96.

Free ammonia: .0425	Albuminoid ammonia: .07
.015	.0275
.005	.015
	.01
	.01
.0625	.1325
2	2
.125	.265

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 97.

In one of the triplicate determinations.

Free ammonia:		Albuminoid ammonia:	
	.01		.09
	.0025		.035
	.0125		.0125
	2		.01
	.025		.0075
			.155
			2
			.31

No. 98.

In one of the triplicate determinations.

Free ammonia:		Albuminoid ammonia:	
	.0725		.40
	.025		.12
	.0075		.06
	.0035		.05
	.1075		.63
	2		2
	.215		.126+

No. 99.

Free ammonia:		Albuminoid ammonia:	
	.28		2.25
	.085		.65
	.03		.19
	.02		.07
	.415		3.16
	2		2
	.83		6.32+

(All permanganate reduced.)

No. 100.

In one of the triplicate determinations.

Free ammonia:		Albuminoid ammonia:	
	3.00		2.31
	.65		.37
	.15		.20
	.06		2.88
	.05		2
	3.91		5.76+
	2		
	7.82		

(All permanganate reduced.)

No. 101.

Free ammonia:		Albuminoid ammonia:
	1.26	(Not determined, it being obvious that
	.48	nitrogenous organic matter in considerable
	.24	quantity had already broken up in the dis-
	.16	tillation for free NH_3.)
	.15	
	.18	
	.56	
	3.03	
	2	
	6.06+	

In the distillation of the last measure the gas was turned so low as to barely keep up ebullition. A long time was occupied in the condensation of this measure; hence the increased yield of NH_3.

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 102.

Free ammonia: 2.40
.62
.60
.56
.50
.54
.56

5.78
2

11.56+

(The first measure probably contained most of the ammonia existing as such in the liquid.)

Albuminoid ammonia.
(Same remark applies as for No. 101.)

No. 103.

Free ammonia: 14.14
7.00
4.625
4.625
4.625
9.25

44.265
2

88.53+

(As in No. 102, the first and second measures seem to have contained most, if not all, the really free NH_3; the rest came from the splitting up of organic matter. In collecting the last measure the lamp flame was *lowered* and the time of distillation doubled; hence the increased yield of NH_3.)

Albuminoid ammonia.
(Same remark applies as for No. 101.)

No. 104.

Free ammonia: .0425
.0125
.0025

.0575
2

.115

Albuminoid ammonia: .08
.04
.02
.015
.01

.165
2

.33

No. 105.

Free ammonia: .14
.04
.015
.01

.205
2

.41

Albuminoid ammonia: .34
.13
.07
.045

.585
2

1.17

No. 106.

Free ammonia: .52
.12
.045
.03
.03

.745
2

1.49

Albuminoid ammonia: 1.87
.38
.12
.08

2.45
2

4.90+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 107.

Free ammonia:		Albuminoid ammonia:	
	.09		09
	.035		.04
	.01		.015
	.005		.015
	.14		.16
	2		2
	.28		.32+

No. 108.

Free ammonia:		Albuminoid ammonia:	
	.48		.36
	.12		.14
	.035		.07
	.015		.05
	.01		.62
	.66		2
	2		1.24+
	1.32		

No. 109.

Free ammonia:		Albuminoid ammonia:	
	.56		1.28
	.22		.22
	.07		.10
	.04		1.60
	.03		2
	.92		3.20+
	2		
	1.84		

No. 110.

Free ammonia:		Albuminoid ammonia:	
	.045		.0175
	.01		.005
	.0075		.0025
	.0075		.035
	.07		2
	2		.07
	.14		

No. 111.

Free ammonia:		Albuminoid ammonia:	
	.24		.045
	.05		.015
	.015		.015
	.0075		.015
	.3125		.090
	2		2
	.625		.18+

No. 112.

Free ammonia:		Albuminoid ammonia:	
	1.00		.09
	.19		.03
	.03		.015
	.01		.015
	1.23		.15
	2		2
	2.46		.30+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 113.

Free ammonia :	.065	Albuminoid ammonia :	.05
	.02		.025
	.005		.0175
	.09		.0125
	2		.0125
	.18		.1175
			2
			.235

No. 114.

Free ammonia :	.14	Albuminoid ammonia :	.0725
	.04		.0425
	.01		.03
	.19		.02
	2		.01
	.38		.175
			2
			.35

No. 115.

Free ammonia :	.64	Albuminoid ammonia :	.16
	.14		.06
	.03		.03
	.005		.02
	.815		.015
	2		.285
	1.63		2
			.57

No. 116.

Free ammonia :	.055	Albuminoid ammonia :	.065
	.02		.0325
	.0075		.015
	.0075		.015
	.09		.1275
	2		2
	.18+		.255+

No. 117.

Free ammonia :	.085	Albuminoid ammonia :	.06
	.035		.03
	.01		.015
	.01		.015
	.14		.015
	2		.135
	.28+		2
			.27+

No. 118.

Free ammonia :	.24	Albuminoid ammonia :	.08
	.075		.035
	.015		.02
	.005		.015
	.335		.15
	2		2
	.67		.30

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 119.

Free ammonia:		Albuminoid ammonia:	
	1.45		.36
	.32		.10
	.05		.055
	.01		.04
			.04
	1.83		.595
	2		2
	3.66		1.19+

No. 120.

Free ammonia:		Albuminoid ammonia:	
	4.32		1.40
	.70		.40
	.30		.16
	.06		.12
	.03		
	5.41		2.08
	2		2
	10.82		4.16+

No. 121.

Free ammonia:		Albuminoid ammonia:	
	33.00		1.04
	8.00		.30
	1.00		.14
	.20		.10
	.06		
	.04		1.58
	.04		2
	.04		3.16+
	42.38		
	2		
	84.76		

No. 122.

Free ammonia:		Albuminoid ammonia:	
	4.33		3.70
	1.05		1.12
	.27		.57
	.075		.45
	5.725		5.84
	2		2
	11.45		11.68+

No. 123.

Free ammonia:		Albuminoid ammonia:	
	7.20		10.00
	1.96		2.10
	.50		.87
	.34		.57
	10.00		13.54
	2		2
	20.00		27.28

(Alkaline permanganate all consumed.)

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 124.

Free ammonia:	14.40	**Albumenoid ammonia:**	18.50
	4.25		7.80
	.85		26.30
	.53		2
	.59		52.60+
	20.62		
	2		
	41.24		

(Alkaline permanganate all consumed.)

No. 125.

Free ammonia:	.90	**Albuminoid ammonia:**	.085
	.18		.040
	.04		.0175
	.015		.0175
	1.135		.015
	2		.175
	2.27		2
			.35+

No. 126.

Free ammonia:	3.06	**Albuminoid ammonia:**	.76
	.44		.28
	.135		.15
	.0275		1.19
	.015		2
	.015		2.38+
	3.6925		
	2		
	7.385		

No. 127.

Free ammonia:	14.00	**Albuminoid ammonia:**	3.60
	3.75		1.14
	.40		4.74
	.13		2
	.05		9.48+
	.045		
	18.375		
	2		
	36.75		

No. 128.

In one of the triplicate determinations.

Free ammonia:	.33	**Albuminoid ammonia:**	.18
	.08		.08
	.015		.05
	.0025		.035
	.4275		.0325
	2		.3775
	.855		2
			.755+

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 129.

Free ammonia:		Albuminoid ammonia:	
	2.10		.70
	.68		.40
	.135		.21
	.035		.16
	.015		1.47
	2.965		2
	2		2.94+
	5.93		

No. 130.

Free ammonia:		Albuminoid ammonia:	
	12.00		1.48
	3.60		.45
	.84		.22
	.20		2.15
	.06		2
	16.70		4.30+
	2		(Alkaline permanganate all reduced.)
	33.40		

No. 131.

Free ammonia:		Albuminoid ammonia:	
	.08		.0675
	.015		.025
	.0025		.0125
	.0975		.01
	2		.01
	.195		.125
			2
			.25+

No. 132.

Free ammonia:		Albuminoid ammonia:	
	.12		.09
	.03		.045
	.005		.02
	.155		.01
	2		.01
	.31		.175
			2
			.35

No. 133.

Free ammonia:		Albuminoid ammonia.	
	.40		.075
	.08		.035
	.02		.0175
	.005		.01
	.505		.1375
	2		2
	1.01		.275

No. 134.

Free ammonia:		Albuminoid ammonia:	
	.22		.15
	.045		.055
	.015		.0325
	.0025		.015
	.2825		.01
	2		.2625
	.565		2
			.525

APPENDIX D.—*Details of collection of "free" and "albuminoid" ammonia, &c.*—Contin'd.

No. 135.

In one of the triplicate determinations.

Free ammonia:	.70	Albuminoid ammonia:	.38
	.14		.19
	.03		.08
	.005		.07
	.875		.72
	2		2
	1.75		1.44+

No. 136.

Free ammonia:	1.76	Albuminoid ammonia:	2.00
	.56		.81
	.12		.40
	.03		.28
	.02		3.49
	2.49		2
	2		6.98+
	4.98		

No. 137.

Free ammonia:	56.80	Albuminoid ammonia:	2.00
	6.77		.90
	.62		.42
	.10		3.32
	.06		2
	64.35		6.64+
	2		(Alkaline permanganate remained in excess.)
	128.70		

No. 138.

Free ammonia:	21.00	Albuminoid ammonia:	2.62
	5.00		.92
	.75		.43
	.15		3.97
	.055		2
	.035		7.94+
	26.99		(Alkaline permanganate almost completely reduced—a slight green tinge only remaining.)
	2		
	53.98		

No. 139.

Free ammonia:	2.10	Albuminoid ammonia:	.44
	.48		.14
	.12		.07
	.03		.055
	2.73		.055
	2		.76
	5.46		2
			1.52+

No. 140.

Free ammonia:	2.28	Albuminoid ammonia:	2.66
	.40		.87
	.105		.40
	.03		.24
	.03		4.17
	2.845		2
	2		8.34
	5.69		

REPORT ON THE RESULTS OF A SUPPLEMENTARY INVESTIGATION, MADE BY DIRECTION OF THE NATIONAL BOARD OF HEALTH, AS TO THE CHEMICAL METHODS FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

By Prof. J. W. MALLET, F. R. S., *University of Virginia.*

ORIGIN AND CHARACTER OF THE RESEARCH.

At the close of the report on the extended investigation of the chemical methods heretofore in use for determining organic matter in potable water, * certain suggestions were made as to possible improvements in these methods tending to remedy defects which had been discovered in the course of the research. By direction of the Executive Committee of the National Board of Health, given during the past summer, the most important of these suggested improvements have been practically studied, and the results are now reported upon.

COMBUSTION PROCESS.

Evaporation of the water under much diminished pressure, in a vessel excluding contact with the atmosphere.—The apparatus employed for this purpose was arranged as shown in Fig. 1.

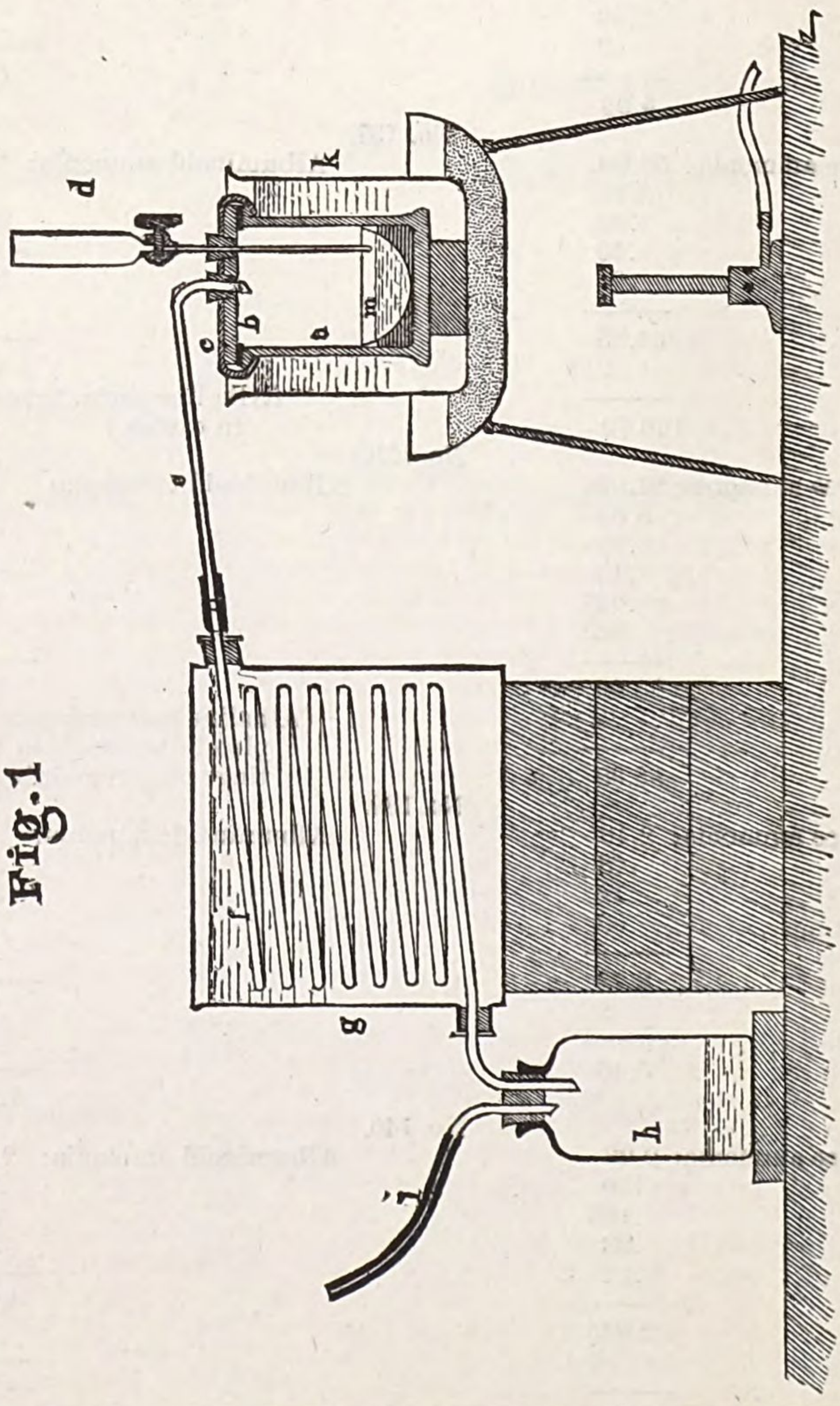


Fig. 1

* See Supplement No. 19 of the National Board of Health Bulletin, May 27, 1882.

The vacuum vessel *a* was a tolerably stout glass jar, such as anatomical preparations are kept in, the mouth of which had been ground flat upon a plane surface, and was covered by a disk of thick plate-glass, *b*, with two bluntly-tapering holes drilled through it. A strip of thick, hard sheet brass, *c*, having two holes in it corresponding to those in the glass disk, served to form a clamp, by which this disk was firmly pressed down upon a ring of sheet India rubber laid as a washer on the ground mouth of the jar. The holes were fitted with good soft India-rubber stoppers, through one of which passed a funnel, *d*, with well-ground glass stop-cock, and tube of almost capillary bore, while through the other passed the glass tube *e*, serving to carry off the vapor as formed, which tube was connected with the block-tin worm *f* surrounded by ice-water in the worm-tub *g*, and delivered water as condensed into the stout bottle *h*, from which the thick India-rubber tube *i* led to the jet-pump, serving to produce exhaustion. The vacuum vessel *a* was supported above the bottom of a large glass breaker, *k*, serving as a water-bath, and this in turn was supported on a sand-bath, *l*, above a Bunsen gas-burner with "rose" top.

The specimen of water to be examined was evaporated in a glass dish, *m*, of about 4 inches in diameter placed at the bottom of the vacuum vessel. At first this dish was supported in an upright position by a brass ring, and only touched the glass of the outer vessel at one point at bottom, but it was soon found that with this arrangement the transmission of heat from the water bath was quite too slow, and hence some mercury was placed in the bottom of *a*, and the dish was immersed in this to a considerable part of its depth. The jar *a* was about 6 inches deep, and of a diameter just sufficient to allow the glass dish to drop down easily, but I should prefer to diminish the depth, and would indeed rather use a simple glass dish, of stout glass, with turned-over lip ground to receive directly the India-rubber washer and plate-glass cover, thus dispensing with the separate vacuum chamber altogether, and leaving but a single thickness of glass between the water bath and the water to be evaporated. As my apparatus was arranged no inconvenience was experienced from vapor of mercury, but in long continued use no doubt enough of this vapor would be given off under the reduced pressure to attack the block-tin worm and make it brittle.

Owing to the slow transmission of heat at the comparatively low temperature employed, the water bath had to be considerably warmer than the water in the dish within. The bath had immersed in it a thermometer, and was kept filled to the proper height by a constant-level feed not shown in the figure. The worm-tub was filled with water at the outset, and afterwards fed with lumps of ice; an overflow tube, also not shown in the figure, served to carry off surplus water. If the apparatus were left at work during the night it would become necessary to supply ice-water to the condenser from a large reservoir by a constant-level feed-pipe. It is desirable that the tubes, both of glass and of block-tin, through which the escaping vapor passes, should have an interior diameter of not less than a third of an inch.

In my experiments the water to be evaporated was introduced, about 50 c. c. at a time, by pouring into the wide portion of the funnel (*d*) and very cautiously opening the stop-cock. This funnel might, however, be replaced by an almost capillary tube with a glass stop-cock upon it, connecting the vacuum chamber with the bottom of a flask containing the whole quantity of water to be evaporated, this flask being placed out of the reach of the heat from the lamp and water bath. After the temperature and pressure within the apparatus have become approximately constant the stop-cock might be set very partially open, so as to allow of continuous supply of more water at just the rate demanded by the progress of the evaporation. In any case the vacuum must be gradually and cautiously established at first, in order to avoid any spattering of the contents of the dish from the escape of bubbles of dissolved gases, and for the same reason each new portion of water must be introduced cautiously, not too much at a time. The stop-cock on the inlet tube must be thoroughly well ground, so as to work and remain tight without any lubricant.

The vertical limb of the exit tube for the vapor should be as short as possible to prevent any risk of liquid water condensing in it and dropping back into the dish, thus producing splashing, and with the same object in view this short, vertical portion of the tube and the whole of the top of the glass covering plate are with advantage to be protected from cooling by some loose cotton wool. The longer limb of the same exit tube should have a decided downward inclination, so as to prevent any condensed water running back.

Using mercury in the bottom of the vacuum chamber, it was heavy enough to rest steadily on its support; but if this were not the case, and there were a tendency to float up, a simple clamp could of course be used to hold the vessel firmly down.

During the greater part of my work the barometer was at something like 745^{mm}, and the mercury in the jet-pump gauge stood at about $690–700^{mm}$. Entire freedom from any return of air or water through the pump, and from any abrupt oscil-

lations of the gauge, was secured by an oiled-silk valve opening only towards the pump, which was inserted in the line of tubing connecting the latter with the evaporation apparatus. The temperature of the water bath was so regulated as to keep the water in the glass dish very near but distinctly below its boiling point for this reduced pressure. The water was therefore evaporated at but little over 30° C., though the thermometer in the water bath was at 55° or 60°. Of course actual boiling must not be permitted, as it would almost certainly lead to loss of water from the dish.

It was found possible to complete the evaporation of half a liter of water in this apparatus between daylight and dark on a long summer day—say within fifteen hours—but of course the rate of evaporation will depend much upon the more or less free consumption of water in running the jet-pump so as to steadily maintain a high degree of exhaustion; and the same amount of water may be treated in less time if with higher pressure a higher temperature be permitted.

In order to test the advantage supposed to be obtainable from this method of evaporating water for the combustion process, organic matter had to be introduced in accurately known quantity, and for this purpose leucine and tyrosine were selected as representing the more stable products of putrefaction liable to occur in natural water, and for which nevertheless the combustion process in its usual form had been found to give results far from satisfactory. Eight experiments were made with each of these substances, using from 5 to 40 milligrams per liter of water. The results of the sixteen combustions were as follows:

TABLE I.—*Amount obtained as percentage on amount originally present.*

	Greatest.	Least.	Average.
	Per cent.	*Per cent.*	*Per cent.*
Leucine:			
Carbon	97.24	91.40	95.77
Nitrogen	95.64	88.27	93.32
Tyrosine:			
Carbon	98.13	92.65	97.04
Nitrogen	97.29	90.45	95.72

These figures show a marked improvement upon the results obtained with the same substances by Mr. Noyes, using the Frankland process in its usual form. There is a much nearer approach to the recovery of the quantities of carbon and nitrogen really present in the water as taken for analysis. The two elements are recovered in much more nearly the true proportion to each other. The error for each is in the same direction, that of partial loss, instead of there being a large *excess* of nitrogen. We may fairly conclude, therefore, that there is real advantage in evaporating the water at the low temperature made available by diminished pressure and with exclusion of atmospheric air.

It is to be observed, however, that there is uniformly *some* loss, although to a comparatively small extent; so that even for analyses made under these favorable conditions it cannot be rightly claimed that the results represent the whole of the organic matter originally contained in the water. Moreover, it is probable that much of the organic matter occurring in natural waters, and it is certain that some of it is of less stable character than the leucine and tyrosine experimented on, and for such less stable material larger losses may be expected.* And, furthermore, Frankland has found that simple evaporation with sulphurous acid, even at a temperature near 100° C., will not suffice to entirely decompose the carbonates of a natural water, but that active boiling of the water for at least a few seconds after the addition of sulphurous acid is necessary.† Some injury to the organic matter may be done by such high temperature, applied even for so short a time, though the mischief will probably be small. In the experiments just recorded sulphurous acid, to the extent of about a third of the usual quantity, was added; but the water was not boiled, there being no carbonates present.

Evaporation of the water with magnesia in order to remove ammonia existing as such or as ammoniacal salts.—Lechartier has advocated‡ the removal of ammonia by evaporation with magnesia, the determination, in the residue, of the nitrogen of organic matter and nitrates, a separate determination of the nitrates, and calculation of the organic nitro-

*It has been found by Dietzell (Berichte d. deutsch. chem. Gesellsch., 15, 551) that during putrefaction very considerable quantities of free nitrogen may be evolved by the formation of nitrous acid and its reaction on leucine, primary amines, and ammonia.

†It might be worth trying whether the decomposition of carbonates could not be advantageously accomplished by some of the acid salts, such as the acid phosphates of calcium, magnesium, or sodium.

‡Comptes rendus, 89; 231. Ann. de Chim. et de Phys. [V]; 19; 257.

gen by difference. It was proposed in my general report to modify this plan by evaporating with magnesia so as to get rid of ammonia, reducing nitrates in the residue—brought to a small volume, but not to dryness—as directed by Frankland, by addition of sulphurous acid with a drop of a solution of a ferrous salt and evaporation to dryness, and finally determining organic nitrogen only in the dry residue by combustion.

In investigating this use of magnesia, however, a difficulty was encountered which vitiates Lechartier's method as well as my proposed modification of it. He says that evaporation with magnesia at the temperature of the water bath, while it completely expels ammonia, does not decompose organic substances, such as urea, and gives in proof of this assertion the results of some experiments, in all of which urea was the only organic substance present. This statement I am unable to verify. I have tried several forms of nitrogenous organic matter liable to occur among the products of putrefaction, and have found that at temperatures no higher than 40° to 50° C. magnesia in the presence of water slowly attacks them, evolving small amounts of ammonia, detectable by litmus paper and paper moistened with the Nessler test solution.

The magnesia was prepared by careful ignition of pure magnesium carbonate, and was very carefully washed to free it from any possible trace of alkali. It was placed with a few cubic centimeters of water and the organic substance to be experimented on at the bottom of a short, wide test-tube, the mouth of which was closed by a cork serving to suspend a strip of the moistened test-paper, and the lower part of the tube was then immersed in a water bath kept at the required temperature.

Salts of the amines on being thus treated very naturally affected the test-papers at once, and even at common temperature. Specimens of urea, both of natural and artificial origin, recently recrystalized, gave the reactions of ammonia distinctly and in a very short time at 40° to 45° C. It is stated that the amic acids are not decomposed with evolution of ammonia even by boiling with solutions of the alkalies, but leucine treated as above described with magnesia at 50° C. gave the reactions of ammonia distinctly though somewhat slowly. Tyrosine behaved in the same way; it seemed to be rather more stable. Benzamide apparently resisted decomposition, at any rate for some minutes, at 55°, but signs of the ammonia reactions began to appear at 100.°

Hence it appears that magnesia cannot be relied upon to expel pre-existent ammonia only from an evaporated water, leaving nitrogenous organic substances untouched. The long-continued contact with the water as its dissolved contents become concentrated, even at the low temperature made available by lowering of pressure, must produce losses of organic nitrogen, which may very possibly be accompanied by loss of carbon from the same constituents.

It may, however, perhaps be the case that in waters containing relatively very large quantities of ammoniacal salts, the error due to the cause under notice would be less than that attributable to the dissociation of these salts, to an extent not accurately determinable during the evaporation.

Reduction and removal of nitrates by evaporation of the water with hypophosphorous acid.—In the main report on this water-analysis investigation it was stated that some preliminary experiments made by myself had seemed to show that nitrates and nitrites may be completely reduced by evaporating to a small bulk with no great excess of phosphorous or hypophosphorous acid, guarding against the evolution of phosphureted hydrogen by the low temperature employed, then adding magnesia in small excess, and completing the evaporation, thus leaving the residue in a pulverulent instead of sticky condition, easy of removal from the dish, and probably allowing of complete combustion without inconvenience from the final oxidation of the small excess of phosphite or hypophosphite, and without any wrapping up of carbon particles. It was suggested that this plan was deserving of being tested. It has now been tested, and with satisfactory results, so far as the experiments have gone. Solutions of tyrosine, 20 parts per million of water, to which 10 parts of nitrogen per million had been added in the form of potassium nitrates (72.2 parts of this salt), were evaporated with 2 to 5 c. c. of a moderately strong solution of hypophosphorous acid. The highly concentrated, but not yet dry, residues were carefully tested for the nitrates by means of leucine, and for nitrate by Griess' naphthylamine reaction, but negative results were obtained as to both. There was no darkening or other apparent indication of the tyrosine being attacked, and on adding magnesia in excess, as proposed, to residues from the evaporation of similarly treated solutions and completing the drying, the combustion in the Sprengel vacuum was carried out without any special difficulty. In a natural water the carbonates present would be decomposed by the hypophosphorous acid, and carbon dioxide would be expelled during the evaporation.

In applying this method, using magnesia to neutralize the excess of acid and to dry up the residue to a condition in which it can easily be removed from the dish and mixed with cupric oxide, care must of course be taken that the magnesia is thoroughly ignited before being used, that it is not exposed to any considerable extent to the air after it

has been prepared; that the evaporation is carried on in such a vacuum chamber as has been described; and that the dried residue is not for any needless length of time exposed to the atmosphere before introduction into the combustion tube. Neglect of these precautions would lead to absorption of carbon dioxide and consequent vitiation of the results as far as carbon is concerned. To avoid, however, the difficulty which had been ascertained to exist, arising from the action of magnesia on nitrogenous organic matter, it was thought best to use barely enough magnesia to neutralize the excess of acid, and to complete the drying up with an addition of pure *silica*, prepared by ignition of silicic acid, itself made from silicon fluoride. With this modification of the plan proposed the combustion gave results for the carbon and nitrogen of the tyrosine as good as those obtained on the average from the solutions of this substance in pure water without additions.

The solution of hypophosphorous acid should be carefully guarded from the air, and its strength ascertained from time to time (in order to judge approximately of the quantity to be used), not by neutralization, but by the reducing action upon a solution of mercuric chloride.

ALBUMINOID AMMONIA PROCESS.

The examination of modified forms of this process was undertaken by Dr. Charles Smart, U. S. A., who has furnished the following statement of results obtained. The appointment of Dr. Smart to the office of secretary to the National Board of Health, and the pressure of duties thus entailed upon him, have prevented the whole plan of experiments intended being carried out, but the main points on which information was sought have been covered.

The experiments detailed below were intended to determine the conditions under which ammonia in small quantities is evolved from its containing liquid and those under which perfect condensation or absorption may be subsequently obtained.

Series of experiments on the liberation and condensation of minute quantities of NH_3.

The charge for distillation consisted of so many c. c. standard NH_3 solution (1 c. c.= .01 mgmrs. NH_3)+ so many ammonia free water, making a total of 500 c. c.

A. 1 mgrm. NH_3, ordinary distillation. Temperature of distillate, 27° C.
. 58 . 21 . 055 . 01 = .855 = 14. 5 per cent. loss.

Compare with H and I.

B_1. .5 mgrm. NH_3, ordinary distillation. Temperature of distillate, 28° C.; temperature in retort, 101° C.
. 40 . 06 . 005 =. 465 = 7 per cent. loss.

B_2. 1 mgrm. NH_3, conditions as in B_1.
. 46 . 10 . 01 . 00 =. 87 = 13 per cent. loss.

Compare with A, in which gas-jet was smaller and time of distillation longer.

B_3. 2 mgrms. NH_3.
1. 34 . 32 . 05 . 015 . 00 = 1. 725 = 13. 75 per cent. loss.

C_1. 1 mgrm HN_3, receiver closed by sulphuric acid bulbs, connected with water jet; tension reduced six inches; retort heated in vessel of boiling water. Temperature in retort, 95°C.; of distillate, 28° C. Distillation slow (90 minutes for 50 c. c.),
. 46 . 28 . 14 . 035 . 015 with . 01 in acid. = 94 = a loss of 6 per cent.

C_2. 2 mgrms. NH_3. Temperature in retort, 96° C; other conditions as in C_1.
. 77 . 56 . 27 . 12 . 06 . 025 with . 035 in acid = 1.84 = a loss of 8 per cent.

D_1. .5 mgrm. NH_3. Conditions as in C, but flame applied to retort. Temperature in retort, 97—97, 5° C.; of distillate, 28° C. Distillation rapid (12 minutes for 50 c. c.).
. 36 . 075 . 01 with . 02 in acid =. 465 = a loss of 7 per cent.

D_2. 1 mgrm. NH_3.
. 72 . 20 . 035 . 015 with trace in acid =. 97 = a loss of 3 per cent.

D_3. 2 mgrms. NH_3.
1. 41 . 36 . 05 . 01 and trace only in acid = 1. 83 = a loss of 8. 5 per cent.

E_1. .5 mgrm. NH_2, ordinary distillation, but receiver closed by sulphuric acid bulbs. Temperature, 101° and 28° C.
. 37 . 075 . 015 with . 02 in acid = 48 = a loss of 4 per cent.

E_2. 1 mgrm. NH_3.
. 72 . 19 . 035 . 005 with . 02 in acid = 97 = a loss of 3 per cent.

E_3. 2 mgrms. NH_3.
1. 39 . 34 . 07 . 01 with . 03 in acid = 1. 84 = a loss of 8 per cent.
Compare E with B.

F_1. 1. 5 mgrm. NH_3. Conditions as in E, but pure water in bulbs instead of sulphuric acid:
1. 12 . 20 . 02 . 005 = 1. 345 = 10.3 per cent. loss.

G_1. . 5 mgrm. NH_3. Conditions as in F, but with water-flask as guard beyond the water-bulbs.
. 37 . 07 . 015 = . 455 = a loss of 9 per cent.

G_2. 1 mgrm. NH_3.
. 72 . 18 . 03 . 0025 and trace in bulb = . 9325 = 6.75 per cent. of loss.

G_3. 2 mgrms. NH_3.
1. 41 . 32 . 065 . 01 with trace in water = 1. 805 = a loss of 9.75 per cent.

Compare G with E and B.

H_1. . 5 mgrm. Ordinary distillation. Temperature of distillate, 6° C.
. 40 . 08 . 02 . 00 = . 50.

H_2. 1 mgrm., as in last.
. 80 . 14 . 03 = . 97 = loss of 3 per cent.

H_3. 1 mgrm., as in last.
. 80 . 15 . 03 = . 98 = loss of 2 per cent.

I_1. . 5 mgrm. condensed in coil 18 feet long. Temperature of distillate, 6° C.
. 08 . 32 . 08 . 015 . 005 = . 50.

I_2. 1 mgrm., as last.
. 43 . 38 . 12 . 04 . 01 = . 98 mgrm.

I_3. 1 mgrm., as last:
. 35 . 40 . 12 . 07 . 03 = . 97 mgrm NH_3.

Second series of experiments on the liberation and condensation of minute quantities of NH_3 from water.

I. . 5 mgrm. NH_3 in a retort connected with a water-jet pump, no condenser, but sulphuric-acid bulbs between retort and pump, $6\frac{3}{4}$ inches pressure removed; stream of air passing through apparatus, entering by means of a glass-wool filter moistened with sulphuric acid; temperature, 28° C. After twenty-four hours . 11 mgrm. NH_3 was found to have left the retort for the acid-bulbs.

II. . 5 mgrm. NH_3, apparatus as in I, but temperature in retort kept at 63° C. At end of twenty-one hours 190 c.c. of the water were found to have passed into the acid-bulbs and flasks, carrying with them all of the NH_3.

III. . 5 mgrm. NH_3, apparatus as last; temperature in retort, 55° C. At end of eighteen hours 85 c. c. were found to have passed over, carrying with them . 488 mgrm. NH_3.

IV. As last. At end of six hours, 31 c. c. had passed over with . 29 mgrm. NH_3.

V. As last, but with the air drawn through the liquid to cause an artificial ebullition. At the end of five hours, . 27 mgrm. was found in the acid.

VI. As last, but with 9 inches pressure removed; temperature, 50° C. At the end of sixteen hours 60 c. c. had come over, bringing all the NH_3

VII. As last. At end of four hours the 10 c. c. which had come over contained only . 25 mgrm. NH_3.

VIII. As last, but with $10\frac{1}{2}$ inches pressure removed; temperature, 49° C., and six and one-half hours of exposure. 13 c. c. passed over, containing . 27 mgrm. NH_3.

Experiments on the decomposition of urea during distillation of the water holding it in solution.

The urea used in these experiments contained . 45 per cent. of free NH_3. This amount must be deducted from the first recorded results of every experiment.

1st. 10 mgrms. urea (containing . 045 mgrm. NH_3) in 500 c. c. water distilled from water-bath, and with $6\frac{1}{2}$ inches pressure removed from interior of apparatus; temperature in retort, 96° C.; two hours required for the distillation of each measure of 50 c. c. Result: 1st measure, . 19 mgrm.; 2d measure, . 37 mgrm.

2d. 10 mgrms. urea, but without the water-bath and jet-pump. Distillation rapid; twelve minutes for 50 c. c. 1st measure, . 12 mgrm.; 2d measure, . 10 mgrm.

3d. 20 mgrms. (containing .09 mgrm. NH_3) operated on as in experiments I, II, III, &c. At end of five hours 40 c. c. had passed over, carrying with them .19 mgrm. NH_3 into the acid.

4th. 20 mgrms. urea were permitted to remain under the influence of the jet-pump and passing air current as in I for forty hours; .14 mgrm. were found in the acid.

5th. 20 mgrms. were exposed in solution to the air for forty hours, and at the end of that time showed the presence of .09 mgrm. NH_3, as when freshly dissolved.

6th. 20 mgrms., at 60° C. and 6½ inches for seven hours, gave .20 mgrm. NH_3 in 40 c. c., which passed over into the acid bulbs.

7th. 20 mgrms., at 60° C. and 6½ inches for sixteen hours, gave in 65 c. c. distilled .25 mgrm. = .16 mgrm. when the .09 free NH_3 is deducted.

8th. 35 mgrm. urea (containing .16 mgrm. NH_3), at 55° C. and pressure as in last, gave, after sixteen hours, 67 c. c., containing .29 mgrm. NH_3.

9th. 35 mgrms. urea, as in last, but with only six hours' exposure, gave .035 mgrm. in 26 c. c. distilled. This .35 represents the decomposition effected during the time, as the residue from 8 was used, and it was free from the original ammonia taint of the urea.

10th. The residue from 9, treated as before for sixteen hours, gave .09 in the 70 c. c. which passed over.

A comparison of C and D shows that water containing a trace of ammonia may be heated within a degree or two of its boiling point without any rapid evolution of the ammonia, but that as soon as the extra degree or two needful to cause ebullition has been added the ammonia passes over rapidly with the watery vapor. Ninety minutes of a heat just below the boiling point are required to accomplish what may be effected in twelve minutes if that point is attained. A reduction of pressure on the surface of the liquid promotes the evolution by causing ebullition at a lower temperature. Compare D with E. A diminished pressure no doubt acts at all temperatures in aiding the evolution, and a weak solution, as in 1, may lose its ammonia at ordinary temperatures, but the length of time required to effect this renders the process valueless as a practical method. Nevertheless, by increasing the temperature under the lessened pressure the time required may be so reduced as to give the process a value in practice.

As the rapidity of the evolution of the ammonia from the water containing it depends mainly on the presence of heat sufficient to boil the water, so a perfect condensation, where heat has been applied to cause rapid evolution, can only be obtained by the needful reduction of temperature. Compare the whole series, A, B, C, &c., with H and I. Where the condensing liquid runs freely from the tap through the condenser so as to give the distillate a temperature a few degrees above the freezing point, the ordinary condenser is as efficient as one with a condensing-tube many times longer. Compare H and I. But where the liberation of the ammonia is effected slowly under reduced pressure and at temperatures considerably below the boiling point, the whole may be recovered by absorption in acid without the aid of a condensing circulation. (See Experiments II, III, and VI.)

As with the evolution of ammonia so with the decomposition of urea; it is effected slowly at temperatures below the boiling point, but as soon as that point is reached the ammonia from its dissolution is given up rapidly. Compare experiment 2 with the others of that series.

Practically it may be said that where we are dealing with free ammonia and non-volatile and stable organic matter in a water the ordinary process with a condensing medium which gives a proper temperature to the distillate may be considered satisfactory. But where we have to discriminate between free ammonia and urea the slower method by absorption in acid under reduced pressure may be of value. The experiments 3 to 8 show that if the operation is commenced in the afternoon and permitted to continue until next morning the whole of the ammonia may be expected in the acid bulbs, and this may be assumed with greater certainty if more than one-tenth of the liquid has distilled in the mean time; but if the operation is commenced in the morning or forenoon it is doubtful if it can be completed in the ordinary working hours of the laboratory. Experiments 7 to 10 indicate that during this liberation of the free ammonia present the urea which may accompany it will only suffer decomposition to the extent of from three to eight-tenths of 1 per cent.

CH. SMART,
United States Army.

PERMANGANATE PROCESS.

Maintenance of an approximately constant excess of permanganate during the progress of action on the organic matter in a sample of water.—The effect of thus modifying the permanganate process as described and used by Tidy was tested as follows: The process was first applied in its usual form to water artificially polluted with organic matter*,

* An infusion of dead forest leaves, and the drainings from a pile of animal manure were the polluting materials used.

extending, however, the time of action to twenty-four hours, and making determinations in separate flasks of the oxygen consumed at the end of one, three, six, nine, twelve, and twenty-four hours, respectively. Enough of the organic matter was used to consume altogether a large proportion of the oxygen of the charge of permanganate. Having plotted off a curve on paper representing the rate of consumption of the oxygen as thus found, it was determined how much additional permanganate should be added at the end of each half hour for the first three hours, at the end of each hour for the succeeding nine hours, and at the end of each six hours for the remaining twelve hours, in order to maintain as nearly as these intervals would permit a constant excess throughout the whole period. These additions were made at the proper times to a new lot of the polluted water, altered only by keeping for one day, and determinations were made as before of the oxygen consumed at the end of one, three, six, nine, twelve, and twenty-four hours.

Results a little higher were obtained by this modified process as compared with those given by the former method. The difference, however, was not very great. The chief evidence of greater regularity of action was furnished by experiments made simultaneously on two different dilutions of the same solution of organic matter. These gave results as to oxygen consumed which were almost exactly in proportion to the difference of strength when the modified process was used, whereas the stronger solutions gave somewhat lower results than would have been calculated from those for the weaker dilutions when the original form of the process was applied.

The comparative experiments were too few in number to generalize from with much positiveness, but they may fairly be taken, as far as they have gone, in confirmation of the soundness of the principle on which the suggested improvement is based.

TABLE XXII. — Nitrites and Nitrates in natural waters examined.

APPENDIX E.

THE REGISTRATION OF VITAL STATISTICS.

By JOHN S. BILLINGS, M. D., *Surgeon U. S. Army, chairman of Committee on Registration and Vital Statistics.*

The subject of registration of vital statistics is one of the most important, and at the same time most difficult, in sanitary as well as social science. Its difficulties are in part due to its apparent simplicity. Before studying it and attempting to obtain practical results, almost every one is disposed to think that he understands it, and is quite ready, not only to undertake the duties of registrar or census superintendent, but to prepare a law or ordinance regulating the matter.

After one has investigated the matter a little, and has become somewhat acquainted with the methods in use, it is not unlikely that he will suppose that he has made some remarkable discoveries of causes of error, imperfect returns, insufficient tabulations, and erroneous conclusions, and will thereupon proceed to prepare a paper criticising the work of his predecessors and proposing reform. It is probable, however, as he continues his studies that he will find that his discoveries are not new, that there are various practical objections to his proposed improvements, and that it is much easier to confine his essay to denunciation of that which is, than to point out clearly and definitely that which ought to be, and which is at the same time practicable.

Vital statistics, in the widest sense of the term, includes the records of all circumstances affecting the production or duration of human life, corresponding almost precisely with the term "démographie," as used by Guillard and other modern French writers. It includes records of the population living at a given period, such as are obtained by the census; and also a record of the changes taking placing in this population by births, marriages, and deaths, such as is obtained by registration. In almost all countries the census of the population and the system of registration, although depending upon each other for much of their interest and value, are nevertheless kept separate as a matter of administration, and are obtained by entirely different methods. It is only where there is no system of registration, as in the United States taken as a nation, that an attempt is made to obtain through the machinery of the census the data which should be derived from current records. But while the results thus obtained are certainly better than none at all, they are extremely imperfect, and lead to serious errors on the part of those who attempt to use them without bearing constantly in mind their incompleteness and liability to mistakes.

The registration of vital statistics properly includes the obtaining of records of births, marriages, deaths, and disease. The comparison of these records with each other, and with those of the living population, form vital statistics proper, and the conclusions drawn from such comparisons form the science of demography or demology.

We have no information that the ancients had any system of registration, although the Jews, Athenians, and Romans took censuses, and it is stated that in China, Japan, and Peru statistical information of this character was collected. In Egypt and in Rome records of births in certain families appear to have been kept, but the first steps towards a general registration were taken through the clergy about the beginning of the sixteenth century. The earliest registers to which I find reference made were those kept at Augsburg and Breslau, which, according to Süssmilch, antedated the order of Lord Thomas Cromwell, in 1538, directing the keeping of parish registers in England.

Little attention, however, seems to have been paid to these English parish registers until 1558, when it was ordered that they should be regularly kept in the churches, and for better preservation should be written on parchment.

In France the first legislation on this subject appears to have been the ordinance of Villers-Cotterets, in 1539. In 1579 the ordinance of Blois directed that there should be brought to the courts at the end of each year the registers of baptisms, marriages, and burials of the several parishes, and by the beginning of the seventeenth century such registers seem to have been in general use throughout Western Europe. Bills of mortality for the purpose of preventing the diffusion of the plague were occasionally issued in London during the latter part of the sixteenth century, and a regular series

of weekly bills commenced in December, 1603, at the end of the great plague, and were then continued regularly until the present system of the registrar-general was established. These bills were under the superintendence of the company of parish clerks of London, first incorporated in 1233, as the "Fraternity of St. Nicholas." In 1625 this corporation obtained a decree from the Star Chamber allowing a press to be kept for the printing of bills of mortality of the city and liberties of London, for which purpose the archbishop of Canterbury appoints a printer.*

In 1629 these bills were arranged to show the distinction of sex and cause of death, and in 1728 the distinction of age was introduced; but the distinction of sex was only shown for the total number of deaths, and not for each disease, nor for each group of ages.

In 1662 John Graunt, who was subsequently made a Fellow of the Royal Society, published a little work entitled "Natural and Political Observations mentioned in the following Index, and made upon Bills of Mortality," of which several editions were subsequently issued. In his epistle dedicatory addressed to John, Lord Roberts, the Lord Privy Seal, he says:

"I conceive that it doth not ill become a peer of Parliament, or member of his majesty's council, to consider how few starve of the many that beg; that the irreligious proposal of some to multiply people by polygamy is withal irrational and fruitless; that the troublesome seclusions in the plague time are not a remedy to be purchased at vast inconveniences; that the greatest plagues of the city are equally and quickly repaired from the country; that the wasting of males by wars and colonies doth not prejudice the due proportion between them and females, &c."

This work of Graunt is the first treatise on vital statistics, and a very good beginning it was.

This first bills of mortality in which the ages were inserted appear to have been those of Breslau, which were used by Halley for the construction of his table of mortality.

In France increased importance was given to the registers kept by the clergy by the decree of April 16, 1667, section 20, which directs that copies of such registers should be accepted as legal proof of the facts set forth.

After the revocation of the edict of Nantes, in 1685, it became difficult and sometimes impossible for Protestants to furnish legal evidence of legitimacy, &c., and it was not until 1787 that the Protestant registers were made legal. After the revolution of 1789 registration passed entirely from the hands of the clergy.

The parochial registers of England were exceedingly imperfect. Even the best of them showed as a rule only the baptisms and burials, not the births and deaths. They were not kept by all religious denominations, nor in hospitals or infirmaries having private burial grounds, and infants dying before baptism were not registered at all. In the old bills these were sometimes entered under the name of *Chrisoms*.

The accounts of these registers given by Mr. Bigland,† Mr. Lucas,‡ and others§ point out in great detail the imperfection of this system. The entries were irregularly made and illegibly written. There was no special care or responsibility for the books, so that some were lost or stolen, etc. Imperfect as it was, however, this was the system brought to America by the early settlers of New England.

In September, 1639, the colony of Massachusetts Bay ordered that births and deaths should be reported to the town clerk by parents and householders within one month of the occurrence of the same. Newly-married men were also to give the clerks certificates of their marriage. Similar orders were made by the Plymouth colony in 1646. (See Appendix, "Massachusetts.")

Rhode Island had similar laws prior to 1698, for they are referred to in the act of May 3 of that year, and probably all the colonies had somewhat similar regulations, but they fell into disuse without being formally repealed.

The present system of registration of births, marriages, and deaths in England dates from the passage of the act of August 17, 1836. This act provided for the creation of the office of registrar general, at a salary of one thousand pounds per annum, and for the appointment of registrars and deputy registrars throughout the kingdom; the district of each registrar to be a portion of a union or parish set apart for that purpose by the guardians of said union or parish, subject to the approval of the registrar-general. The registrars were authorized and required to inform themselves of every birth and death happening within their districts, and to ascertain and register as soon after the event as conveniently could be done, without fee or reward, the particulars required to be registered according to the schedules appended.

This law was followed by the act, passed in 1837, to explain and amend the previous

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*Burrows on Paris Registers, &c., London Medical Repository, 1818, vol. x, p. 277.

†Observations on marriages, baptisms, &c., as preserved in parochial registers, 1764.

‡An impartial inquiry into the present state of parochial registers, &c., 1791.

§For further history as to early registration consult Süssmilch, J. P. Die Göttliche Ordnung in den Veränderungen des menschlichen Geschlechts. Editions of 1775 (4th) or 1798. And the article "Mortality," by Milne, in the Encyclopædia Britannica.

acts. This act placed the establishment of the boundaries of the registration districts entirely within the power of the registrar-general, provided for the appointment of deputy superintendent registrars, and, also, that all registrars should be free and exempt from serving on any jury or inquest. The registrar's office was to be provided and furnished at the expense of the Board of Guardians, and for that purpose they were authorized to borrow money and charge it on the future poor-rates; and in case such Board of Guardians neglected or refused to provide such office, then the commissioners of the treasury should do so at an expense not exceeding three hundred pounds in each case, and should collect the money from the guardians.

The present system of registration of births and deaths in England is regulated by the act passed in August, 1874. A copy of so much of the acts of 1836, 1837, and 1874 as are of special interest in connection with this subject is appended.*

A sketch of the early history of registration in the United States is given by Dr. Sutton as an appendix to the second annual report of the registration of births, marriages, and deaths in Kentucky for the year 1853.

From this, and from an examination of the various registration reports which have been published, it is evident that, in the great majority of the States, the actual registration is exceedingly imperfect, and one would be greatly deceived if he were to judge of these systems by the laws which have been enacted. Copies of nearly all of these State laws are given in an appendix, accompanied with brief memoranda as to the results in the several States; but they are given not so much for the purpose of showing what has actually been done as to indicate what those who have advocated registration have thought ought to be and could be done.

A brief review of the difficulties and objections which are met with in attempting to provide a complete system of State registration may be useful.

There are four principal objects for a systematic registration of births, marriages, and deaths on the part of a community.

The first is for legal purposes, being intended to identify individuals in their relations to their families and to the community, and its utility and desirability rests upon substantially the same grounds as those of the recording of titles of property.

The remark of Dr. Snow, made twenty years ago, that it would probably be impossible for a large portion of the middle-aged men and women in the United States to prove that their parents were ever married, and that they have any legitimate right to the name they bear, no doubt still holds good to a great extent.

The second purpose is for the prevention and detection of crime.

The third object, so far at least as births and deaths are concerned, is to furnish data for sanitary purposes, that is, to give warning of the undue increase of disease or death presumed to be due to preventable causes, and also to indicate the localities in which sanitary effort is most desirable and most likely to be of use.

The fourth object is to collect data for scientific purposes as bearing on the laws of human development. It will be seen that the character of the information required differs somewhat for these several objects. For legal purposes the main object is the identification of the individual, the verification of the fact of birth or death, and the ascertaining that the death is due to what are commonly called natural causes. For scientific and sanitary purposes the identification of the individual is of minor importance, as it is required only for the purpose of preventing duplication of the records.

While the importance of all these objects will usually be readily admitted, it will be found, in attempting to frame a State law for the registration of vital statistics, that there will be objections urged, and that there will be many practical difficulties in its enforcement, no matter what its provisions may be. The principal objection urged by legislators to the passage of such a law will be the cost of the system, and a constant effort will be made to induce those presenting the bill to have the figures for compensation placed at the lowest possible point. As I have stated in a previous report, the attempt to secure complete and satisfactory registration through the voluntary contribution of information by heads of families or by physicians, or by requiring insufficiently paid registrars to obtain the information desired, has always been a failure. As legislators reflect in a general way the state of public opinion in the localities whence they come, it is evident that, unless this public opinion has been educated to a certain extent with regard to the importance and value of registration, there is small probability of the passage of any satisfactory law, and still less probability that it will be properly executed if passed.

The first and greatest difficulty in educating the people upon this subject is to get them to understand the objects of the registration. Those who have never given any attention to the subject are apt to suppose that it is merely a hobby of the doctors, who want the information for their own private purposes, and that this information can only be obtained by an unjustifiable amount of meddling with private affairs and by a system of espionage which will cause much trouble and difficulty.

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* For further details as to the English system consult Glen. The law relating to registration (&c.), 2d ed. London, 1875.

These objections are, however, of small importance in comparison with the absolute indifference as to the whole matter which prevails throughout the community, nor do the objections often turn upon the practical difficulties in enforcing such laws, seeing that the objectors are in most cases profoundly ignorant of these difficulties.

Dr. Sutton remarks that legislators will insist upon amending the most carefully drawn bill so as to secure greater cheapness and what they suppose to be greater simplicity in the machinery, until it sometimes happens that those who have been most active in preparing and urging a law lose their interest in it, and may even become opponents, because they see that it has been so mutilated as to be inefficient or impossible of execution. In this country it has been proved by repeated experiments that it is impossible, by legislation which involves neither payment nor penalty, to induce parents or householders to report the births and deaths which have occurred under their respective jurisdiction to the registrars, whoever they may be. Even in cases where this has been required of them under penalty no one will attempt to enforce a law which inflicts penalties not sanctioned by public opinion.

A registration law which is upon the whole theoretically satisfactory not unfrequently becomes practically useless, owing to the character of the person who is selected to supervise its execution. It has happened that the person selected to collect and compile the data of registration for a State has been a politician for whom it was desirable to provide an office and who had no other qualifications for the place.

The object of such persons is to do as little as possible and to avoid arousing inquiry or opposition by calling attention to defects. If, for the sake of economy, the duty is placed upon some existing officer of the State, as for example, the librarian, or the secretary of the senate, or the secretary of state, and no provision of funds is made whereby this officer can employ a really competent man to do the work, the results are certain to be of comparatively little value, for without a properly qualified supervising officer it will not be possible to avoid omissions and errors on the part of the local registrars.

The most difficult of all the problems of registration in this country is how to obtain a complete record of the births in a given locality, nor can we say that it has anywhere been completely and satisfactorily solved. In a report on registration made by Dr. E. M. Snow to the Fourth National Quarantine Convention held in Boston in 1860, the best methods of obtaining records of births, especially in cities, were discussed. His conclusion was that the requiring parents to furnish the desired information is in this country useless; that the requiring physicians to report births occurring in their practice is equally useless; and that the only method by which returns of births can be obtained in cities with any approach to fullness and correctness is by requiring the recording officer to obtain the information personally or by his agents; in other words, by sending at periodic intervals some one to call at every house and obtain the data for the births which have occurred there since the last visit. It seems very doubtful, however, as to whether this method would obtain all the births in our large cities, and especially among the floating population. Probably a combination of this method with those pursued in France and Great Britain to obtain the same end would have the best effect.

The French law as regards the registration of births is contained in articles 55, 56, and 57 of the civil code, which are as follows:

"ART. 55. Declaration of births shall be made within three days from the delivery to the civil officer of the place. The infant shall be presented to him.

"ART. 56. The birth of the infant shall be declared by the father, or in default of the father, the doctors of medicine, surgeons, midwives, or other persons who have assisted at the labor; when the mother is not delivered at her own house, by the person at whose house she has been delivered. The registration of births shall be made in the the presence of two witnesses.

"ART. 57. The registration of births shall state date, hour, and place of birth, sex of the infant, and the names which are given to it; also the names, occupation, and residence of the father and mother, and those of the witnesses."

An omission to make the declaration exposes the physician to the relatively severe penalty prescribed by article 346 of the penal code, which is as follows:

"ART. 346. Every person who, having assisted at a labor, does not make the declaration prescribed by article 56 of this code, shall be punished by imprisonment of from six days to six months in prison, and fined from sixteen to three hundred francs."

The construction of the last clause of article 55 appears to have varied in different parts of France and the neighboring countries, such as Belgium and the Netherlands, which have substantially carried out the same law. In the larger cities it appears to have been required that the new-born infant should be taken to the city hall at all seasons. The wealthier class could have the verification made at the house by the payment of a fee, but the poor were obliged to take their children to the office of registration, whether they were strong or weak, sick or well. To obtain the certificate of birth and baptism at the house the fee was from fifty to sixty francs.

In the country, and in small towns, the mode of execution of the law varied, but

usually the birth of the infant was registered without requiring it to be carried to the office of the registrar.

The evil results of requiring a new-born infant to be taken from its home to the registering office in all seasons has often been pointed out, and a certain proportion of the mortality of new-born infants in the colder seasons has been attributed to this custom.

Of late years, however, it appears to have become more and more customary to consider the declaration of the father, or in his absence that of the accoucheur or midwife, with that of two witnesses, sufficient without actually seeing the child. The matter appears to be entirely at the discretion of the local official.*

The English law does not require the presentation of the infant at the office of registration, nor need the declaration of birth be made under forty-two days. The result of this is a certain imperfection in the registers in the case of those children who die within the first week of life, since many of these do not appear upon the registers either of births or deaths.

The duties imposed upon physicians and midwives by the articles of the French code relative to the registration of births have been the subject of several essays and reports, the more important of which are the report of Demange, Devergie, and Géry, in the Bulletin of the Société de médecine légale de Paris, vol. i, 1869, p. 385, and by M. H. Hémar, avocat-géneral in Bulletin of the Société de médecine légale de France, vol. iv, 1875–'76, p. 250.

From these it appears that the physician is compelled to make the declaration of birth in all cases where he has a reasonable certainty that the child in question has actually been born of its reputed mother while the latter was under his charge, although he may have been absent at the precise moment of the delivery of the child. As a matter of fact the physician often makes the declaration in cases where the evidence as to the identity of the child is not legally sufficient, as in cases where he is well acquainted with the mother, has known of her pregnancy, of the fact of her delivery, and is assured that the child presented is the identical child delivered.

The most important difficulty in carrying out this law, so far as the physician is concerned, relates to the name of the mother, which the physician has no right to declare when this has been confided to him in the exercise of his profession, and when the person interested has requested him not to reveal it. It has been decided by competent authority, first, that the physician who reports to the registrar an infant at the birth of which he has attended is not compelled to declare the name of the mother when he states that he only knew it under the seal of secrecy. Second, that the obligation to declare the birth imposed by article 346 of the penal code is fulfilled when the person present at the labor purely and simply declares the material fact of the birth conformably to article 56.

The declarant is not compelled to furnish the information given in article 57, and this is especially the case with regard to physicians and midwives, upon whom article 378 of the penal code imposes secrecy. Article 378 is as follows:

"Physicians, surgeons, and other officers of health, also pharmaceutists, midwives, and all other persons, depositaries by their condition or profession of secrets confided to them, and who, setting aside the case in which the law compels them to become denunciators, shall have revealed these secrets, shall be punished by imprisonment of one to six months and fine of one hundred to five hundred francs."

The registrars admit the right of the physicians to keep secret the name of the mother and to declare an infant from an unknown father or mother, but they have refused to receive the declaration of the physician unless he would state the residence of the mother. It is, however, evident that the statement of the residence is almost equivalent to giving the name.

It has recently been decided in the case of Dr. Lutaud, who read a paper on the subject before the Medico-Legal Society of Paris, that he should be allowed to make declaration of the birth of an infant without declaring either the name of the parents or their residence, further than to state that the residence was within the district of the registrar.

Another question in connection with the registration of births relates to the matter of the registration of the still-born. Some physicians return as still-born all children that survive for only a few hours or for a day or two, and they also report as still-born children which are born prematurely and lived several days. Upon this point the recommendation of the committee of the American Medical Association in 1859 seems satisfactory, viz, that all returns should be strictly in conformity with fact, that still-born include only those which are dead when born, whether mature or immature, and that the still-born should be placed in a distinct table and the same facts

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* See memoir on the registration of births in France, by Dr. Loir, Annales d'hygiène, vol. 34, 1845, p. 452. Also, report of M. De Villiers, on the verification of births, Bulletin de l'Académie de médecine, vol. 32, 1866–'67, p. 607, and Dr. Matthyssens, on the presentation of new-born infants to the registrar, Annales de la Société de médecine d'Anvers 1849, vi. p. 401.

as to sex and time of birth shown as in the general table. The same should be done with regard to cases of plural births.

We cannot, however, hope to obtain any entirely satisfactory system of registration of births until the people at large have become educated to the necessity for it, and are induced to seek such registration of their own accord in order to secure proof of legitimacy, title to property, &c. Under the provisions of the English registration act the physician or midwife has no special duties in connection with the registration of birth, the duty of notifying the registrar falling upon the father or mother or householder, who are required to furnish this information within 42 days after the birth.

In England, the duty of the registrar is, not to sit at home waiting for a presentation of the infant, as in France, but to go himself to the locality and register the birth. The notice given may be either verbal or written, and, while the registrar is obliged to visit the dwelling, he is not necessarily obliged to see the child.

In Russia, according to information kindly furnished by Prof. Jules Johnson, of the University of St. Petersburg, the registers are not public documents as in France or Germany. "They are kept by the parish priest. Each parish church receives at the end of the year three books; one for the registration of baptisms (not births), another for that of marriages, and a third for deaths. For dissenters (*Les ras kolniki*) the copying of these books has been done by agents of the police since 1874; before this date the births, marriages, and deaths of the *ras kolniki* were not recorded at all, and even now there are no laws compelling dissenters to have these facts registered. If the *ras kolniki* wishes to have his child registered by the law as legitimate he must furnish the information, if not, not; and as the ordinary custom of the Russian people makes no distinction between legitimate and illegitimate children, the necessity for registration rarely occurs. For more than 11,000,000 of the Russian people there is no registration; the remainder have the parish books. The law gives no indication as to the persons who are obliged to report the facts of birth; ordinarily it is the parent or friend, who goes to the priest and requests him to perform the ceremony of baptism; nor does the law state within what time the infant should be baptized. In villages this is ordinarily done on the third day. In other classes of the population sometimes a year or more elapses before the child is baptized and registered in the parish book. It is evident that most of those born dead are not registered at all in these books. Sometimes they are in the record of death. The law says nothing with relation to those born dead, nor does it define what should be understood under this term. All births where the name of the father is unknown are counted as illegitimate, as well as where the father is not the husband of the woman. The woman of the lower classes rarely conceals the fact of an illegitimate birth. She has no need of doing so, because an illegitimate birth is not a disgrace among her neighbors and friends. The woman of the higher classes has, on the other hand, all the means of concealing it, by sending the child to the church, by no matter whom, and having it registered, without giving the name of the mother. Neither the attending physician nor the midwife has anything to do with the baptism or registration of the child.

"The fact of death is ordinarily promptly announced to the priest by some of the parents or friends. The priest goes to the house to read prayers, and on the third day he proceeds to the burial, after which he records that such and such a person was buried. No certificate of the physician, no permission of the police, except in case of violent death, is necessary for burial. It is only in some large cities, and with reference to sanitary statistics only, that a statement of the cause of death takes place, either by the attending physician or by the physician of the police. Ordinarily this last gives the certificate of death without even having seen the disease, and a permit of burial is given, without which no priest has the right to perform the burial service. If the Russian people were to lose its religious feeling there would be no registration whatever."

The following is a translation of the two chapters of the civil code of Mexico which relate to the registration of births and deaths.

RECORDS OF BIRTH.

ART. 75. All births must be reported within fifteen days after the occurrence. The child must be exhibited to the civil judge in his office or at the parental home.

ART. 76. In localities where there is no civil judge the child must be exhibited to the chief local authority of the district, who will issue the proper certificate, which the interested parties must deliver to the corresponding civil judge, who will have it recorded.

ART. 77. The birth of the child must be reported by the father or, in his absence, by the physicians, surgeons, midwives, or other persons who were present at the delivery; and if this has taken place elsewhere than in the parental home, by the person in whose house it took place.

ART. 78. The registry of birth will be made immediately in the presence of two witnesses, who may be named by the interested parties. It must designate the day, hour, and place of birth, sex of child, its individual and family name, noting the fact of its exhibition, dead or alive.

ART. 79. If the child is presented as the offspring of a legal marriage the register must contain the names and residences of the father and mother, grandfather and grandmother, both paternal and maternal, and the name of the person who presented the child.

ART. 80. If the child is not legitimate, only the name of the father or the mother will be registered, if they should make a request to that effect, either themselves or by special attorney, and in all such cases a petition must be presented.

ART. 81. If neither the father nor mother can appear in person nor by attorney, and both or either one of them request the attendance of the civil judge, then this functionary will go to the place where the interested party or parties may be, and will there receive the petition that his or her name be expressed, and all this will be entered on the register.

ART. 82. If the parents of the illegitimate child do not solicit that their names be given, the entry will be to the effect that the child presented is of unknown parents. If one of the parents should ask for an entry of his name, then his name shall be registered and not that of the other parent.

ART. 83. If the child is the offspring of adulterous intercourse (adulterino), the name of the married father or mother cannot be registered, even if the parties should make such request; but the name of the single father or mother, if such there be, may be registered.

ART. 84. If the child is borne by a married woman who lives with her husband, then in no case, nor at the request of any person whosoever, may the civil judge register as father any other person than the same husband.

ART. 85. If the child should be illegitimate, only the name of one parent can be registered.

ART. 86. Any person who finds a child recently born, or in whose house or property such is deposited, must present the same to the civil judge, with the clothes, papers, or any other objects found therewith, stating the time and place of finding the same, as well as such other circumstances as occurred in the particular case.

ART. 87. The same obligation devolves upon the chiefs, directors, and administrators of prisons and any other public establishments, especially hospitals, foundling asylums, and lying-in hospitals, respecting the children born or deposited on their premises.

ART. 88. In the record made in such cases must be specified all the circumstances expressed in Article 86, the apparent age of the child, its sex, the name it receives, and that of the person or the foundling house in whose charge it may be.

ART. 89. All papers, jewels, or other objects found with the foundling, and which may lead to its identification, must be deposited with the archives of the registrar's office, mentioning the same in the record, and giving a receipt in proper form to the person who has taken charge of the child.

ART. 90. The civil judge, as well as the witnesses, who, according to Article 78, must attend at the act, are absolutely prohibited from making any direct or indirect inquiries respecting the paternity. The record will only express what the persons presenting the child should say, even if suspected of falsehood.

ART. 91. Whenever the birth takes place on board of a national vessel the interested parties must sign a certificate, setting forth the fact and all circumstances, specified in Articles 78 to 85 in reference to other cases, and request the captain or mate and two witnesses of the persons on board to authenticate said certificate. If there be no witnesses this circumstance must be noted.

ART. 92. The interested parties will deliver the certificate spoken of in the preceding article to the civil judge of the first national port where the vessel arrives, whose duty it is to record the document according to its tenor.

ART. 93. If there should be no functionaries of this class, then the aforesaid certificate must be delivered to the local authority, who will immediately transmit the same to the civil judge of the place where the parents reside.

ART. 94. If the birth should occur on board of a foreign vessel, it will be necessary to observe the provisions of Article 15 respecting the formalities of registry.

"ART. 15. Respecting the external formalities of contracts, wills, and all other public instruments, these documents are subject to the laws of the country where executed. Mexicans and foreigners residing abroad are, however, at liberty to comply with the formalities and provisions of Mexican law in those cases where acts are to be executed within these limits."

ART. 95. The birth, taking place during a voyage by land, must be registered in the place where it occurs, and a copy of the record must be transmitted to the civil judge of the place where the parents reside, if they should call for it, and in this case the judge will enter it on the respective book.

ART. 96. If the birth and death of the child are reported at the same time, both facts must be recorded on the respective books.

ART. 97. In cases of the birth of twins, the civil judge must register the particular marks which distinguish them, and state which child was born first according to the information given by the physician, matron, or persons who were present at the delivery.

RECORDS OF DEATH.

ART. 135. No burial will take place without a written permit, issued by the civil judge, who will exercise proper caution in ascertaining the fact. The dead body will not be interred until twenty-our hours afterthe decease, except when the police orders otherwise.

ART. 136. The record of death will be inscribed in the respective book, which must contain the data obtained by the civil judge or the declaration made before him and signed by two witnesses, preference being given in this case to the parents, if there be such, or to the neighbors. If the person died outside of his habitation, then one of the witnesses must be that person in whose house the decease took place or one of the most immediate neighbors.

ART. 137. The record of death must contain:

I. The full name of the deceased, his age, profession, and residence.

II. If married or widowed, the full name of his mate.

III. The full names, age, profession, and residence of the witnesses, and, if relatives, the degree of relation.

IV. The names, if known, of the parents of the deceased.

V. The name and character of the disease which caused the death, and the precise location of the grave.

VI. The hour of the decease, if known, and all other information obtainable in case of violent death.

ART. 138. The owners and occupants of houses in which a death occurs; the superiors, directors, and administrators of prisons, hospitals, colleges, or any other houses where people live in common; the keepers of hostelries and hotels, and the housekeepers of tenement houses are obliged to notify the judge of the civil register within twenty-four hours after the decease.

ART. 139. If the death occurs at a place where there is no registry office, the district, and in its absence the municipal, authority will assume the duties of the civil judge, transmitting to the latter a copy of the record it has made, so that he may enter it on his book.

ART. 140. If the judge has reason to suspect that the death was violent, he will report it to the judicial authority, communicating all the information he has, so that it may institute nn investigation according to law. The judicial authority when making such investigation must notify the judge, so that he may record the fact. If the name of the deceased is unknown, a description of the body and also of his clothes, as well as anything which at any time may serve to identify the person. All further data obtained must be communicated to the judge of the civil register, in order to be noted in the margin of the record.

ART. 141. In cases of inundation, shipwreck, conflagration, or any other, rendering it difficult to identify the body, the record will be drawn from the declaration of those who recovered the body, giving as far as possible a description and the clothes or objects found with the same.

ART. 142. Whenever the body is not recovered, while it is positively known that some person has perished at the place of the disaster, the record will contain the declaration of the persons who have known the deceased, and all further notices obtainable respecting the event.

ART. 143. In case of natural death at sea, and on board a national vessel, the record will be drawn as far as possible in the manner prescribed in Article 137, and authenticated by the captain or mate of the vessel. The provisions of Articles 92 and 93, respecting births, should also be complied with.

ART. 144. Whenever any person dies at a place not his residence, a certified copy of the record will be transmitted to the judge of the place of residence, in order to have it entered in the respective book, noting the transmission on the margin of the original.

ART. 145. The chief of any corps or detachment of the national guard is obliged to report to the civil judge all the deaths occurred in a campaign or any other action of the service, giving descriptions of bodies, and the civil judge will act as provided in reference to deaths outside of residence.

ART. 146. Whenever a sentence of death is executed, the tribunals will be careful to transmit notice of the fact within twenty-four hours to the civil judge of the place where the execution took place. This notice must contain the full name, condition (whether single or married), age, and profession of the person executed.

ART. 147. In all cases of violent death in prisons or houses of detention, and in those from execution of justice, these circumstances will not be stated on the registers, and the records will contain simply the requisites prescribed in Article 137, with quotation of the present.

ART. 148. The fact of death will be noted on the registers of birth and matrimony, with due reference to the folio of the registers of death.

In Austria the registration of births is performed by the clergy of those denominations recognized by the Government. For other sects the report must be made to civil officers. Births must be reported by the father. In case of his absence, or of illegitimacy, the report is to be made by the midwife or physician. The report must be made within a week. The presentation of the child is not required, the statement of the midwife or accoucheur made under oath being accepted instead. The secret of the mother is preserved when she demands it, usually by the use of a fictitious name. Deaths are reported by the nearest relative or householder, a permit for burial being required in all cases. These permits are issued upon the presentation of a report of the autopsy, which must in all cases be made by the officer appointed for that purpose.

In Sweden registration remains under the charge of the clergy, based upon the original law of 1686. The following particulars are taken from a communication kindly furnished by M. Siedenbladh, the director of the bureau of statistics of Sweden:

"The duty of reporting births devolves on the parents, and is usually performed when the child is brought to the font. If the baptism is omitted, which is sometimes the case, the birth nevertheless must be reported. In case of illegitimacy the right of concealing her name is granted to the mother, even though the delivery has taken place in a public institution. When the child is born in a private home, and the mother wishes to remain unknown, the midwife generally reports the birth for registration. The reports must be made within six weeks. Still-born are reported. Every living birth is registered as a living child, no matter what the period of gestation. Registration is performed by the clergy, which is, almost without exception, Evangelical Lutheran. The function of registering is also exercised by the clergy, or the heads of the few parishes not Lutheran (Catholic, Jewish, and one Baptist).

"*In case of deaths.*—Every deceased must be interred in a church yard, and for obtaining burying place it is necessary for the relations, or, in want of them, for the police office, to report to the clergy for burying the deceased; but if there is any suspicion of crime committed, the police has the decision whether the burial must be preceded by a medico-legal inquest or not. In town the clergy requires a certificate from the town physician, or the physician who had the deceased under his care.

"When *in town*, the physician's certificate is required; it must contain the cause of death, which is thereupon written in the register of deaths by the clergyman.

"In the country generally only those causes of death are written in the register that may be stated by not medical men as violent deaths (including suicides) and zymotic diseases, *i. e.*, smallpox, scarlet fever, measles, fever, cholera, &c."

The following particulars with regard to registration in Norway have been kindly furnished by L. Dahl, the director of vital statistics in that country. Registration of births are made by the rector of the parish at the baptism, or at the burial of the unbaptized. In case of still-births, or of infants dying within twenty-four hours after birth, the reports must be made by the attending physician or midwife, and the name of the woman and the precise place of residence must be stated. In the larger towns such births must be reported within eight days. In the country the period is fixed by legal regulations. Children born before the twenty-eighth week of gestation are usually not reported or registered. The rector of the parish, who is the registering officer, does not usually see the infant before baptism, but accepts the evidence given by those who report the birth to him. The facts required to be registered with regard to the infant are the following: Locality, date of birth, name, sex, legitimacy; as to the parents, the civil station, trade, occupation, name, residence, year of nativity, congregation, nationality. Deaths must be reported by the nearest relative or the householder. A permit for burial is required, which is given by the rector of the parish, but he cannot give this permit until the death has been reported to the board of registration.

In most towns the physician who has treated the deceased during his last illness must give the certificate of death and its cause. In case of death without medical attendance the official physician of the district commonly verifies the death and its cause. In the country there is no legal verification of deaths, but every practitioner must yearly furnish a report of all cases of death, with their causes and the age and sex of the deceased.

In Italy births are to be reported by the parents; if illegitimate, by the mother; but if she does not wish to be known, the midwife must report the births as of unknown parents. In the exceptional case of a physician being present at birth instead of a midwife, it is his duty to report the fact. In case of a birth where the mother wishes

to preserve secrecy, the person reporting the birth is required to give the precise address and add the statement that the mother wishes to remain unknown. The child must be presented at the registrar's office, but the registrar may dispense with this when the birth is otherwise verified to his satisfaction. In case of children dying within five days it is to be reported that the child is dead, and the law does not demand the report as to whether the child was born dead or died soon after birth. All children born after four months' pregnancy must be reported according to the law, but custom has fixed the period at six months. The official registrar is the mayor or syndic, but the duty is always delegated to the communal secretary.

A special difficulty in the registration of births is the fact that the child may not be named for several weeks or even months after birth.

It is much easier to secure a complete registration of deaths than of births, since it is comparatively easy to enforce a law that a permit shall be necessary for every interment or removal of a dead body, and the community soon learns to consider any attempt at burial without a permit as a suspicious circumstance, indicating a desire to conceal either the death or the cause of death, and justifying a special investigation by the authorities. When it has been decided to require a burial permit in all cases, there is no difficulty in requiring the data necessary for registration as an indispensable preliminary to the issue of such permit.

A complete system of the registration of deaths should include some method of verification of the death and of its cause, by a person having the special knowledge necessary for that purpose.

This skilled verification is necessary, first, to insure the fact of a death having taken place. In its absence, in a large city, there is little or no difficulty in having recorded the death of a person who may be either non-existent or alive and well.

Second. It is necessary to insure the fact of real, as opposed to apparent, death in any case, and thus to prevent premature burial.

Third. It is necessary to establish the fact that a death has taken place from what may be called natural causes, as opposed to criminal causes. This verification of death and of the cause of death may be made either by physicians employed for that particular purpose, and receiving payment from the state, or by the physician under whose charge the deceased person has been previous to death, only those cases which have not been under the treatment of a physician being referred to a public medical officer or the coroner for verification.

The first system is that employed in France, Belgium, and Austria; the second is the one made use of in England and this country. This matter will be discussed further in speaking of the methods of ascertaining the cause of death. All registration laws include physicians as an essential part of their machinery. Some do this directly, by requiring that physicians shall keep a list of all deaths occurring in their practice, and shall forward this list at stated times to the registrar. This method has always proved a failure, as has the similar requirement of clergymen that they shall furnish lists of marriages. Where burial permits are required, a physician may be made responsible for a certificate as to those matters only about which his special professional knowledge is necessary, such as the cause of death, duration of sickness, &c., or he may be required to certify also to age, birthplace, parentage, &c. To this last class of requirements there are objections which are worthy of consideration, since although it is true that the great majority of physicians furnish the information required without any attempt to question the propriety of the law, still there are always some who will object and a few who will positively decline. The matter can perhaps be best illustrated by taking some of the objections which have been actually urged, and for this purpose we may take first the statement of Sir Dominic Corrigan as to his reasons for refusing in certain cases to fill out death certificates required under the Irish act. In a paper in the Dublin Quarterly Journal of Medical Sciences, vol. li, 1871, p. 341, after stating that he has refused to fill out the certificate required under the Irish act, he proceeds to give his reasons:

"The words of the act are that the medical practitioner who shall have been in attendance during the last illness and until the death, &c., is to fill up and sign the certificate. No man can be considered as in attendance until the death unless he was *present at the death.* The interval of an hour equally with that of a month intervening between his last visit and the death puts him out of the category of being in 'attendance until death.' The certificate requires a medical practitioner to certify to three things: the day of the death, cause of the death, and the length of time the disease had continued. In eight years since the passage of the act only one case has occurred in which he could certify of his own personal knowledge that death did occur on a particular day. He asks how can a medical practitioner in the majority of instances certify as to duration of disease, information with regard to which must in a great majority of cases be got together on hearsay evidence. A man cannot be compelled to certify to what he is not certain of; therefore no such acts can be enforced under a penalty. In Ireland the penalty is that of misdemeanor, but no official has ever ventured to bring a recusant into court."

With this may be compared the objections urged by Dr. Buckingham, in the Boston

Medical Journal, 1868, vol. i, p. 225. He objects to the law, saying "the fact that he saw a man during his last sickness, though years before he died, makes him liable to penalty if he refuses to fill a certificate, although no one may have been in attendance when the man died.

"Certificates are often filled out by persons with no medical education, but who call themselves physicians. Physicians certify to the cause of death, age, &c., when they should refuse any certificate in cases where they have no data by which to judge either of the age or sickness except statements of some friend.

"The law does not provide that the last attendant shall give it, but any physician having attended a person during his last illness. The undertakers desire certificates because they get a fee, and registrars desire certificates because for each entry they get a fee. The physician is required to give a certificate without fee and liable to fine if he does not give it."

On this letter there was a comment by Dr. Derby, same vol., p. 265.

He replies that with regard to age, duration of disease, &c., that they are merely embraced in the certificates signed by the physician for the sake of simplicity of form, that they are practically filled up by the relations or friends, and that no physician need hesitate to certify to them any more than as to the date when he himself was born. We must take the evidence of others as conclusive in circumstances of daily occurrence.

Dr. H. M. Lyman, in the Chicago Medical Journal, 1878, p. 252, gives voice to the feeling of passive resistance on the part of a certain number which is felt, but not usually expressed, viz, that registration laws may do very well for countries where people have been trained for generations to acquiescence, but that they are at war with the principles of democratic government and individual freedom. "In this country there is only the curiosity of a few scientific men that can be relied upon for the moral support of a registry law, and it is probable that in Chicago not more than 12 in every thousand would be found to care for the registration of their nativity even in a family Bible. The reason why physicians do not execute the law is because they not only have no personal interest in its execution, but because of an invincible, though not always clearly recognized feeling of revolt against the injustice of a law which inflicts a special tax on the physician in the shape of postage, time, and trouble, and affords no compensation for the extra labor and expense. People do not like to make a present to Government in any shape or form. It is as unjust for the State to add fifty cents to the doctor's tax simply because he is a doctor as it would be to add fifty dollars. The State should pay for all such service and it need not incur any great expense. It might, as in the case of jury duty or military service by conscription, fix its own rate, but the obligation should be recognized. The payment would, of course, require increased general taxation, but the increase would then be levied on all alike. The health officers are trying to get service from the doctors without paying for it."

In the Chicago Medical Journal for 1879, vol. 38, p. 148, Dr. Lyman continues this subject by calling attention to the New Hampshire statute allowing twenty-five cents to each physician for recording. He says:

"I am assured that it is perfectly effectual, and that in no part of the world are vital statistics being perfected, as in that little Old Granite State! In Minnesota, the State values these statistics sufficiently to pay not less than forty cents for registration of each birth and death."

While the views presented by Dr. Lyman are not those of the majority of the medical profession, who in this, as in many other ways, are willing and ready to give gratuitous service for the public good, they are, nevertheless, important in a legal point of view, and should be borne in mind in attempting to devise any legislation on the subject. Attempts to compel under penalty physicians to report age and birthplace of their patients are worse than useless. I do not think that the offer of any fee which would be considered reasonable by legislators would have much influence in inducing physicians to report births and deaths, and Dr. Lyman is in error in supposing that New Hampshire or Minnesota have obtained any useful results in this way. The true policy is to call upon medical men to supplement the information which should be demanded from the parent or householder.

As regards births it is bad policy to require under penalty reports of such from medical men, and no sufficient reason exists for so doing. With regard to deaths there is much truth in Dr. Snow's remark that the habit of signing death certificates is incidentally of benefit to physicians, as it makes them more careful in diagnosis.

With regard to the registration of marriages, the present law of Rhode Island upon the subject, as recently amended, seems to be capable of securing complete returns, and to be just and reasonable in its provisions. In very few of the laws regarding registration, which require the information from physicians, is there any definition or regulation as to who are to be considered as physicians by the registering authorities. As a matter of fact, in most cases the certificate of any one who chooses to sign himself or herself as a physician is accepted. The result is necessarily to defeat

to a certain extent one of the judicial purposes of registration, viz, the detection of cases of unnatural death, and the punishment of the person causing them, and also to greatly diminish the value of the return for statistical purposes, so far as the several causes of death are concerned.

All registration acts which are upon a proper basis presuppose also legislation providing for the determining of those who are properly qualified physicians, and for making the names of these known to the registrar. It may be said, therefore, that the registration of vital statistics depends for its efficiency, to a very large extent, upon some system of registration of physicians and midwives.

The question as to the connection between registration and the work of sanitary authorities, and whether it is desirable that registrars should be distinct from boards of health, is one that has several times been raised. The principal discussion on this matter has occurred in the city of Boston, where the matter of registration is in the hands of a registrar who is not a physician and has no connection with the health authorities. Attempts have been several times made to place the registrar's office under the board of health, and petitions for this purpose have been forwarded extensively by physicians in order to avoid the annoyance of being compelled to get two certificates for each death, one of which goes to the registrar and the other to the board of health, the latter being necessary in order to procure a permit for burial. As a rule, there is no doubt that registration will be best managed by sanitary authorities, and where these exist they are in this country usually intrusted with it, both as a matter of economy and because the information which it furnishes with regard to deaths is essential to their work.

The subject of the registration of disease has of late years received much attention in England, which has been taking the lead of all other countries in sanitary matters, and the second report of the royal sanitary commission, presented in 1871, contains a very good summary of the reasons for urging such registration as a Government measure. After commenting on the defects and errors of mortality registration, the commissioners remark:

"However complete the registration of deaths may be, it cannot give a fair estimate of the grief and poverty occasioned by sickness that is not fatal; it cannot indicate where or how these are to be prevented or remedied; it cannot tell the cost which is worth incurring for their diminution. To these ends the first step must be a registration, so far as may be practicable, of all the cases of the most prevalent and injurious sicknesses among such portions of the population as may suffice for an estimate of the general state of the public health, and especially to keep the central sanitary authority constantly aware of the state of the public health in every part of the country. In nearly all cases of epidemic and contagious diseases time is lost before the deaths—few in comparison with the cases—begin to attract attention. In many instances, weeks have elapsed before the existence of widely prevalent and preventable disease has become known to any efficient sanitary authority. Thus the best opportunities are lost both of ascertaining the origin of epidemics and of preventing or limiting their spread. The chances of suppressing an outbreak of disease are in direct proportion to the speed with which it becomes known to a sanitary authority."

Unfortunately, it is much easier to prove that records of disease furnished by all practitioners would be valuable, than to devise any practicable plan by which such records can be obtained. It is in fact impossible to obtain such records for all diseases, and it is difficult to obtain them even for a few of the more important and contagious diseases, although this can be and has been done in cities.

It is not proposed here to discuss the question of the compulsory notification of infectious diseases by all physicians, but, to show the prevailing opinion in England on this subject, the following resolutions passed by the British Medical Association in August last are given, viz:

"That in view of the unanimous opinions of all competent sanitary authorities that notification is the indispensable basis of action for arresting the spread of infectious disease, and of the general testimony as to the satisfactory operation of the acts which have already been passed by the legislature to make such notification compulsory, this meeting declines to withdraw the approval which the association has repeatedly expressed in favor of urging Parliament to make the notification of infectious disease generally compulsory, under such conditions as may appear to be, after due inquiry, best calculated to protect the public health.

"That this meeting earnestly desires compulsory notification of infectious disease, but it wishes to express its opinion that the compulsion to notify should be placed upon the householder as his duty as a citizen, and not upon the doctor."

Setting aside the question as to compulsory notification by physicians, it is perfectly possible to obtain very interesting and practically useful information from records of the cases of disease occurring among the sick poor who receive medical treatment at the expense of the public, and to do this at comparatively small expense; and it is curious that in none of our large cities, so far as I know, is any attempt made to collect this information day by day for the use of the health department. It is also

possible to obtain valuable information for sanitary authorities in a city through the department of public schools. Something has been done in this direction in the city of Oakland, Cal., Dr. Woolsey's report with regard to which will be found in the National Board of Health Bulletin, vol. ii., p. 447, and the results of which are given in the annual report of the health officer of Oakland for 1880. By this system the principals of the several public schools report monthly the number of pupils absent three or more consecutive days on account of alleged sickness, and copies of these reports are furnished to the health officer by the superintendent of schools. The results obtained are of statistical interest, but come too late in many cases to serve as a warning. A proper form of report to be kept by the teachers would give the age of each pupil, the residence, and the nature of the alleged sickness. The consolidated report should be furnished to the health officer every week, and cases of alleged contagious disease should be reported at once, with the name of the attending physician, if there is any.

These items just mentioned are by no means the only ones which should be recorded with regard to pupils of public schools from a sanitary point of view, for there should be noted with regard to each child upon entering school the condition of the eye and ear, whether vaccinated, whether it has had scarlet fever, measles, whooping-cough, &c., but these points are not required in the weekly warning report.

Reports of sickness in the police force and other municipal employés can also be obtained without much trouble; and where there are large manufacturing establishments it will usually not be difficult to obtain regular reports of serious accidents and illness among the workmen. In short, a health officer of tact, who maintains pleasant relations with the medical profession, will be able to obtain a large amount of interesting and useful information with regard to the prevalence of disease without resorting to compulsory legislation, which in many cases at present will be found to be rather a hinderance than a help.

Let us now consider briefly the items to be required in a system of registration of births, deaths, and marriages. The following tables indicate what is required in different States and municipalities, and show at a glance those points which all statisticians consider as essential, as distinguished from those with regard to which there is more or less difference of opinion:

Table showing for each State having registration laws the date of the act and mode of obtaining information with regard to births.

State.	Date of act.	Who to report births.			Time of reporting births.	Fee for reporting births.	Who to record births.	Fee for recording births.
		Physician, midwife.	Parent, householder, etc.	Town, county, and school officers.				
						Cents.		
Alabama	Feb. 28, 1881	x	x	.....	Prescribed by county board of health.	.....	County health officer	
California		x	.....	.....	Quarterly	10	County recorder	
Connecticut	Feb. 28, 1877	x	.....	.....	Monthly	10	Town register	10 cents.
	Jan. 1878							
Delaware	1862	x	.....	.....	Semi-annually or annually	15	County recorder of deeds	10 cents.
	Apr. 7, 1881	.....	.....	.....	Quarterly	5		5 cents.
Georgia	Session Jan.	x	.....	.....		.....	County ordinary	
	and Feb. 1875							
	Jan. 1876	.....	.....	.....		.....		5 cents.
Illinois	May 25, 1877	x	x	.....	Within 30 days	.....	County clerk	
Indiana	Mar. 7, 1881	x	x	.....	Within 15 days	.....	Secretary of town board of health	
Iowa	Mar. 26, 1880	x	x	.....	Within 30 days	.....	County clerk	10 cents.
Kentucky	1851	x	.....	x	Annually	2[1]	Auditor of public accounts	
	1878	.....	.....	.....		.....	Secretary of State board of health	
Maine	Feb. 28, 1821	.....	x	.....	Within 6 months	.....	Town clerk	
	1865	.....	.....	x		.....		
Maryland	1865	.....	x	.....	Within 6 months	.....	Clerk of county circuit court[2]	15 cents.
Massachusetts	Sept. 4, 1639[3]	.....	x	.....	Within 1 month	.....	Town clerk or register keeper	1*d.*
(Colony Massachusetts Bay)	Mar. 7, 1644[3]	.....	.....	.....		.....	Clerk of the writs	3*d.*
(Plymouth Colony)	Oct. 20, 1646[3]	.....	.....	.....		.....	Town clerk or register keeper	
Province Massachusetts Bay	1692–'93[3]	.....	.....	.....	Within 30 days	.....	Town clerk	
	1742[3]	.....	.....	.....		.....		4*d.*
	1750[3]	.....	.....	.....		.....		2*d.*
	1796	.....	x	.....	Within 6 months	.....	Clerks of towns and districts	
	Mar. 16, 1844	.....	.....	x	Annually	5	do	8 cents.
	May 2, 1849	.....	.....	.....		20	Clerks and registrars of towns and districts[4]	50 cents.
	1880	x	.....	.....	Monthly	.....		
Michigan	1869	.....	.....	x[5]	Annually	10	Clerk of county or township	
Minnesota	Mar. 4, 1870	.....	x	.....		.....	Town and city clerks	25 cents.
New Hampshire	June 25, 1858	.....	.....	x	Annually	.....	do	
	July 29, 1881	.....	.....	.....		.....		25 cents.[6]
New Jersey	Mar. 3, 1848	.....	.....	x	Annually	5	Clerks of townships	

	Mar. 19, 1851	x	x	.....	Within 1 month	10	.....	
	Mar. 11, 1862	.....	.....	x	Annually	5	.....	5 cents.
	Mar. 9, 1877	.....	.....	.....	.....	.....	Clerks of county boards of health	
	1879	x	x	.....	Within 30 days	.....	Assessors of townships, clerks of cities	10 cents.
New York	Apr. 28, 1847[7]	.....	.....	x	Annually	(*)	Town clerk or alderman of school district	(*)
	May 29, 1880	x	.....	.....	Within 30 days	.....	Town clerk	
North Carolina	1881	.....	.....	x	Annually	.....	Secretary of state	
Ohio	1880	x[8]	.....	x	.....do	.....	Probate judge of county	
Pennsylvania	Apr. 14, 1851	x	.....	.....	Within 30 day	.....	County register of wills	10 cents.[9]
Rhode Island	1698	.....	x	.....	Within 10 days	.....	Town clerks	4*d.*
	Oct. 1701	.....	.....	.....	Within 2 months	.....	.....	
	1844	.....	.....	.....	.....	.....	.....	
	1850	.....	x	.....	Within 3 months	.....	Trustees of school districts	
	1852	.....	.....	.....	.....	.....	City and town clerks	10 cents.
South Carolina	Dec. 20, 1853	x	x	x	.....	.....	District and parish tax collectors	3 cents.
	Dec. 20, 1856							
	Dec. 21, 1858	x	.....	.....	.....	.....	.....	5 cents.
Tennessee	Apr. 5, 1881	x	x	.....	Within 30 days	.....	County court clerks	3 cents.
Vermont	Nov. 17, 1856	.....	.....	x[10]	Annually	15	Town clerks	5 cents.
Virginia	Apr. 11, 1853	.....	.....	x[11]	do	.....	Clerks of county and corporation courts	
	1855	.....	.....	.....	.....	3	.....	3 cents.
England	Aug. 17, 1836	.....	x[12]	.....	Within 42 days[13]	.....	Registrar of district	
	June 30, 1837							
	Aug. 7, 1874	.....	.....	.....	.....	.....	.....	1*s.*

[1] To assessors only.
[2] Clerk of the court of common pleas of Baltimore.
[3] General courts, held at dates given.
[4] Registrars may be elected in towns 10,000 population and upwards.
[5] Persons appointed by city council of Detroit.
[6] For *obtaining* and recording, 50 cents to town and city clerks.
[7] Makes especial legislation for New York City.
[8] In counties containing towns of 150,000 population and upwards, who must report quarterly.
[9] Register of county and city of Philadelphia, 6 cents.
[10] Does not apply to the clerk of the city of Burlington.
[11] Physicians and heads of families must report to commissioners of revenue.
[12] Master or keeper of every jail, prison, house of correction, workhouse, hospital, &c., shall, for the purpose of this act, be deemed the occupier thereof. The master of a vessel shall report by mail to the registrar-general, immediately on arrival at any port in the kingdom, births that may have occurred on his vessel.
[13] May be reported within 6 months to the superintendent registrar, who shall be entitled to 2*s.* 6*d.* fee for recording same.
* Fixed by county board of supervisors.

Table showing for each State having registration laws the date of the act and mode of obtaining information with regard to deaths.

State.	Date of act.	Who to report deaths.			Time of reporting deaths.	Fee for reporting deaths.	Who to record deaths.	Fee for recording deaths.
		Physician, midwife.	Parent, householder, &c.	Town, county, and school officers.				
						Cents.		
Alabama	Feb. 28, 1881	x	x	x	Prescribed by county board of health	.....	County health officer	
California	.....	x	.....	x	Quarterly	10	County recorder	
Connecticut	Feb. 28, 1877	x	x	.....	Within 10 days after burial	10	Town register	10 cents.
	Jan. ses., 1878							
Delaware	1862	x	.....	.....	Semi-annually	.....	County recorder of deeds	10 cents.
	Apr. 7, 1881	x	.....	x	Quarterly	5	.....	5 cents.
Georgia	Session Jan.	x	x	x	.....	.....	County ordinary	
	and Feb., 1875							
	Jan. 1876	.....	.....	.....	.....	.....	.....	5 cents.
Illinois	May 25, 1877	x	x	x	Within 30 days	.....	County clerk	
Indiana	Mar. 7, 1881	x	x	x	Within 15 days	.....	Secretary of the town board of health	
Iowa	Mar. 26, 1880	x	x	.....	Within 30 days	.....	County clerk	10 cents.
Kentucky	1851	x	.....	x	Annually	2[1]	Auditor of public accounts	
	1878	.....	.....	.....	.....	.....	Secretary of the State board of health	
Maine	Feb. 28, 1821	.....	x	x	Within 6 months	.....	Town clerk	
	1865	.....	.....	x	.....	.....	.....	
Maryland	1855	.....	x	[1]	Within 6 months[2]	.....	Clerk of county circuit court[3]	15 cents.
Massachusetts	Sept. 4, 1639	.....	x	.....	.....	.....	Town clerk or register-keeper	3*d.*
(Colony Massachusetts Bay)	Mar 7, 1644[4]	.....	x	.....	Within 1 month	.....	Clerk of the writs	3*d.*
(Plymouth Colony)	Oct. 20, 1646[4]	.....	.....	.....	.....	.....	.....	.....
(Province Massachusetts Bay)	1692–'93[4]	.....	.....	.....	Within 30 days	.....	Town clerks	
	1742	.....	.....	.....	.....	.....	.....	4*d.*
	1750	.....	.....	.....	.....	.....	.....	2*d.*
	1796	.....	x	.....	Within 6 months	.....	.....	
	Mar. 16, 1844	.....	x	.....	Monthly	5	Clerks of the cities and towns	2 cents.
	May 2, 1849	.....	.....	.....	.....	.....	.....	5 cents.
	1878	x	x	.....	Before burial	.....	.....	35 cents.
	1869	.....	.....	x[5]	Annually	10	Clerk of county or township	
Michigan	Mar. 4, 1870	x	x	x	..... do	.....	Town and city clerks	25 cents.
Minnesota	June 25, 1858	[6]	.....	x	Annually	.....	.....	
New Hampshire	July 29, 1881	.....	.....	.....	.....	.....	.....	25 cents.[7]
New Jersey	Mar. 3, 1848	.....	x	.....	Monthly	5	Clerks of common council and boards of aldermen of cities and clerks of townships.	5 cents.

	Mar. 19, 1851	.....	.....	.....	.....	10	.....	10 cents.
	Mar. 11, 1862	.....	.....	.....	.....	5	.....	5 cents.
	Mar. 9, 1877	.....	.....	.....	.....	.....	Clerks of county boards of health, where established.	
	1879	.....	.....	undertaker	Within 5 days after burial	.....	.....	.....
New York	Apr. 28, 1847[8]	.....	.....	x	.....	(*)	Town clerks or one of the aldermen of school districts.	(*)
	May 29, 1880	x	.....	.....	Within 3 days	.....	Town clerks	
North Carolina	1881	.....	.....	x	Annually	.....	Secretary of state	
Ohio	1880	x[9]	.....	x	..... do	.....	Probate judge of county	
Pennsylvania	Apr. 14, 1851	x	.....	.....	Within 30 days	.....	County register of wills	10 cts.[10]
Rhode Island	1698	.....	x	.....	Within 10 days	.....	Town clerks	4*d.*
	Oct. 1701	.....	.....	.....	Within 2 months	.....	.....	
	1844	.....	.....	.....	Within 3 months	.....	.....	
	1850	x	.....	.....	.....	.....	Trustees of school districts	
	1852	.....	.....	.....	.....	.....	City and town clerks	10 cents.
South Carolina	Dec. 20, 1853	x	x	x	.....	.....	District and parish tax collector	3 cents.
	Dec. 20, 1856							
	Dec. 21, 1858	x	x	.....	.....	.....	.....	5 cents.
Tennessee	Apr. 5, 1881	x	x	.....	Within 30 days	.....	Clerk county court	3 cents.
Vermont	Nov. 17, 1856	x	.....	x[11]	Annually[12]	15	Town clerk	5 cents.
Virginia	Apr. 11, 1853	.....	.....	x[13]	Annually	.....	Clerks of county and corporation courts	
	1855	.....	.....	.....	.....	3	.....	3 cents.
England	Aug. 17, 1836	.....	x[14]	x	Within 8 days	.....	Registrar of district	
	June 30, 1837							
	Aug. 7, 1874	.....	.....	.....	Within 14 days	.....	.....	1*s.*

[1] To assessors only.
[2] Sexton, coroner, undertaker, in the case of a stranger or friendless person.
[3] Sexton, coroner, or undertaker, within 1 month.
[4] Clerk of court of common pleas of the city of Baltimore.
[5] General courts held at dates given.
[6] Persons appointed by city council of Detroit.
[7] Physicians shall report to town and county officers.
[8] For *obtaining* and recording, 50 cents to town and city clerks.
[9] Provides especial regulations for New York City.
[10] In counties containing towns of 150,000 population and upwards *physicians* must report *quarterly*.
[11] Register of county and city of Philadelphia shall receive 6 cents.
[12] Does not apply to clerk of city of Burlington.
[13] Physicians shall report within 15 days after burial.
[14] Physicians, parents, householders, coroners, &c., shall report to commissioner of revenue.
* Fixed by board of supervisors.

Table showing items of registration in regard to births, required in different States and cities of the United States and in certain foreign countries.

	Date of birth.	Place of birth.	Sex.	Color.	Name.	Father's name.	Mother's name.	Birthplace of parents.	Father's occupation.	Age of parents.	Residence of mother.	Number of children by this mother.	Whether illegitimate.	Whether still-born.	Name of informant.	Parents' residence.	Date of record.
STATES.																	
Alabama [3 6]	x	x	x	x	x	....	....	x	x	....	....	....	....	....	x	....	....
California	x	....	x	x	....	x	....	....	....	x	....	....	....	....	....	x	....
Colorado	x	x	x	x	....	x	x	....	....	....	....	....	....	....	....	x	....
Connecticut [1 2 3 11]	x	x	x	....	x	x	x	x	x	x	....	x	x	x	....	x	....
Delaware	x	x	x	....	x	x	x	x	x	x	....	x	....	x	...	....	x
Georgia [10]	x	x	x	x	x	x	x	x	....	x	....	x	....	....	....	....	....
Illinois	x	x	x	x	x	x	x	x	x	x	....	....	....	....	x	....	....
Indiana	x	x	x	x	x	x	x	x	x	x	....	....	x	x	x	....	....
Iowa	x	x	x	x	x	x	x	x	x	x	x	x	x	....	x	....	....
Massachusetts [2]	x	x	x	x	x	x	x	x	x	....	....	....	x	....	....	x	x
Michigan	x	x	x	x	x	x	x	x	x	....	....	....	....	....	....	x	x
Minnesota	x	....	x	....	x	x	x	x	x	....	....	....	....	....	....	....	....
New Hampshire	x	x	x	x	x	x	x	x	x	x	....	....	....	x	....	x	....
New Jersey [1]	x	x	x	x	x	x	x	x	x	x	....	x	x	....	x	....	....
New York [1]	x	x	x	x	x	x	x	x	x	x	....	x	x	x	x	....	x
Ohio	x	x	x	x	x	x	x	....	....	....	....	....	....	....	....	x	x
Pennsylvania [1 4]	x	x	x	x	x	....	x	....	x	....	....	....	....	....	x	....	....
Rhode Island [3 2]	x	x	x	x	x	x	x	x	x	x	....	x	....	x	x	....	....
Tennessee [9]	x	x	x	x	x	x	x	x	x	....	....	....	....	....	....	x	x
Vermont	x	x	x	....	x	....	....	....	x	....	....	....	....	....	....	x	....
Wisconsin [4]	x	x	x	x	x	x	x	x	x	....	....	....	x	x	x	....	....
CITIES.																	
Baltimore, Md	x	x	x	x	....	x	x	x	x	....	....	x	....	x	x	....	....
Boston, Mass	x	x	x	x	x	x	x	x	x	....	....	....	....	....	....	x	....
Burlington, Vt	x	x	x	x	....	x	x	x	x	....	x	....	....	x	x	....	....
Charleston, S. C	x	x	x	x	x	x	x	x	x	x	x	x	....	....	....	....	....
Cincinnati, Ohio	x	....	x	x	x	x	x	x	x	....	....	....	....	....	....	x	....
Galveston, Tex	....	....	x	x	x	x	x	....	....	....	....	....	....	x	x	....	....
Mobile, Ala. [6]	x	x	x	x	....	x	x	x	x	....	....	....	....	....	x	....	....
New Orleans, La. [7]	x	x	x	x	x	x	x	x	x	x	....	...	x	....	x	x	....
New York	x	x	x	x	x	x	x	x	x	....	x	x	....	....	x	....	x
Philadelphia, Pa	x	x	x	x	x	x	x	....	x	....	....	....	....	....	....	....	....
Saint Louis, Mo	x	x	x	x	x	x	x	x	....	....	....	....	....	x	x	....	....
FOREIGN COUNTRIES.																	
Germany [5]	x	x	x	....	x	x	x	....	x	....	....	....	x	....	....	x	....
Sweden [5 8]	x	x	x	.. .	x	x	x	x	x	x	....	....	x	x	....	....	....
Austria	x	x	x	....	x	x	x	....	....	....	....	....	....	....	....	....	....

[1] These States call for number of children now living.
[2] These States call for whether twins.
[3] These States call for parents' color.
[4] These States call for names of other child or children living.
[5] This country calls for religion of parents.
[6] These places call for presentation.
[7] This city calls for mother's occupation.
[8] This country calls for civil condition of mother.
[9] This State calls for kinship of parents.
[10] This State calls for, if premature, period of utero-gestation.
[11] This State calls for race.

Table showing items of registration in regard to deaths, required in different States and cities of the United States, and in certain foreign countries.

	Name.	Sex.	Age.	Occupation.	Place of birth.	Civil condition.	Legal residence.	Duration of residence.	Place of death.	Date of death.	Color.	Cause of death.	Complications.	Duration of disease.	Father's name.	Mother's maiden name.	Parents' birthplace.	Date of burial.	Place of burial.	Name of informant.	Date of record.
STATES.																					
Alabama	x	x	x	x	x	x	...	x	x	x	x	x	...	x	x	x	...	...	x	x	...
California [2]	x	x	x	x	x	x	...	...	x	x	x	x	...	...	...	...	x	x	x	...	...
Colorado [5]	x	x	x	x	x	x	...	...	x	x	x	...	...	...	...	...	...	...	...	...	...
Connecticut [2 3 4]	x	x	x	x	x	x	x	...	x	x	x	x	x	x	x	x	x	...	...	...	...
Delaware	x	...	x	x	x	x	x	...	...	x	x	x	x	...	...	x	...	...	...	...	...
Georgia	x	x	x	x	x	x	..	...	...	...	x	x	...	...	...	...	x	...	x	...	...
Illinois	x	x	x	x	x	x	...	x	...	x	x	...	x	...	...	...	...	x	x	...	...
Indiana	x	x	x	x	x	x	x	...	x	x	x	x	...	x	x	x	...	...	...	x	...
Iowa	x	x	x	x	x	x	...	...	x	x	x	x	x	...	...	...	...	x	x	...	x
Kentucky	x	x	x	x	x	x	x	...	x	x	x	x	...	...	x	x	...	...	...	...	...
Maryland	x	x	...	x	x	x	x	...	x	...	...	x	..	...	x	x	...	...	x	...	...
Massachusetts	x	x	x	x	x	x	x	x	x	x	x	x	...	...	x	x	x	...	...	...	...
Michigan	x	x	x	x	x	x	...	...	x	x	x	x	...	...	x	x	...	...	...	...	x
Minnesota	x	x	x	...	x	x	...	...	...	x	x	x	...	...	x	x	x	...	...	...	x
New Hampshire	x	x	x	x	x	...	...	...	x	x	...	x	...	...	x	x	x	x	x	...	...
New Jersey	x	x	x	x	x	...	x	...	x	...	x	x	...	...	...	...	...	...	...	...	...
New York [7]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	...
North Carolina	x	..	x	...	...	...	x	...	...	x	x	x	...	...	...	...	...	...	...	x	...
Pennsylvania [1]	x	x	x	x	...	...	x	...	x	...	x	x	...	...	x	x	...	x	x	x	x
Rhode Island	x	x	x	x	x	x	...	...	x	x	x	x	x	x	x	x	x	...	x	x	...
Tennessee [8]	x	x	x	x	x	x	...	...	...	x	x	x	...	...	x	x	...	...	...	...	x
Vermont	x	x	...	x	x	...	...	...	x	x	...	x	...	...	x	x	...	...	...	...	...
Virginia [1]	x	x	x	x	x	x	...	...	...	...	x	x	...	...	x	x	...	...	...	...	...
Wisconsin [1]	x	x	x	x	x	...	...	...	x	x	x	x	...	...	x	x	...	...	x	x	...
District of Columbia	x	x	x	x	x	x	...	x	x	x	x	x	...	...	...	...	...	x	x	..	...
CITIES.																					
Baltimore, Md	x	x	x	x	x	x	...	x	x	x	x	x	...	...	...	...	...	x	x	...	...
Boston, Mass	x	x	x	x	x	x	x	...	x	x	x	x	...	x	x	x	x	x	x	x	...
Burlington, Vt	x	x	x	x	x	x	...	...	x	x	x	x	...	...	...	...	...	...	...	...	...
Charleston, S. C	x	x	x	x	x	...	...	x	x	x	x	x	...	...	...	...	...	...	...	...	...
Cincinnati, Ohio [6]	x	x	x	x	x	x	x	x	...	x	x	x	...	...	x	x	x	x	x	..	...
Galveston, Tex [2]	x	x	x	x	x	x	...	x	x	x	x	x	...	...	...	...	...	...	...	...	...
Jacksonville, Fla	x	...	x	...	x	...	...	x	x	x	...	x	...	...	...	...	...	...	...	...	...
Mobile, Ala. [5 6]	x	x	x	...	x	x	...	x	x	x	x	x	...	x	x	x	...	x	x	...	...
New Orleans, La. [2]	x	x	x	x	x	x	...	x	x	x	x	x	...	...	x	x	x	...	...	...	...
New York	x	x	x	x	x	x	...	x	x	x	x	x	...	x	...	...	x	...	x	x	...
Philadelphia	x	x	x	x	x	x	...	...	x	x	x	x	...	...	x	x	...	x	x	...	...
Portland, Me. [4 9]	x	...	x	...	...	...	...	...	x	x	...	x	...	...	...	...	...	x	x	...	...
Richmond, Ind	x	x	x	...	x	x	x	...	...	...	x	x	...	x	...	...	...	...	...	...	...
Richmond, Va	x	x	x	x	x	x	...	x	x	x	x	x	x	x	x	x	...	x	x	x	...
San Francisco, Cal. [2 6]	x	x	x	x	x	x	...	...	x	x	...	x	...	...	...	...	x	x	x	...	...
Savannah, Ga	x	x	x	x	x	x	x	x	x	x	x	x	...	...	...	...	...	...	...	...	...
Saint Louis, Mo	x	x	x	x	x	x	...	...	x	x	x	x	...	...	...	...	...	...	x	...	...
Wilmington, Del	x	x	x		x		x			x	x										
FOREIGN COUNTRIES.																					
England [10]	x	x	x	x					x	x		x		x	x					x	
Sweden	x	x	x	x	x	x			x	x		x									
Norway	x		x	x		x	x		x	x		x	x	x						x	
Brussels	x		x	x	x	x	x			x		x									
Buda-Pest	x	x	x	x				x				x	x	x							
Frankfort-on-the-Main	x	x	x	x		x						x		x							
Hamburg	x	x			x	x	x					x									
Vienna	x	x	x	x	x			x				x	x	x							
												x									

[1] These States call for name of husband or wife.
[2] These States and cities call for race.
[3] This State calls for maiden name of wife or widow.
[4] These places call for, if wife or widow, of whom?
[5] These places call for, when and where disease contracted.
[6] These places call for previous residence.
[7] This State calls for hour of death.
[8] This State calls for kinship of parents.
[9] This city calls for name of parent.
[10] This country calls for, if wife or widow, of whom?

	Religion.	Mode of feeding infant.	Artificial nurses.	Illegitimacy.	Age of the oldest child.	Street and number of house.	Story of house.	Day of death.	Hour of death.	Medical aid.	Prosperity.	Separate bed-rooms.	Number of rooms and lodgings.
Buda-Pest	x	x	x	x	x	x x	x	x x	x	x x	x x	.....	.....
Frankfort-on-the-Main	....	.....	....	....	.....	x x	...	x x	...	x x	x	x	x
Hamburg	....	.....	....	....	.....	x x	x	x x	x x	x	....	.....	.....
Vienna	x x	.....	x	....	.....	x	....	x	x	....	....	.....	.....
Sweden	x	.....	....	....	.....	.....	....	....	....	....	....	.....	.....

The table relating to births shows that the following items are provided for in nearly all systems, viz, date and place of birth, sex, color, and name of child; names, residence, and birthplace of parents, and occupation of father. The age of the parents, the number of the child in the family, its legitimacy, and whether born dead, are required in a less number of cases.

With regard to age, it is usual to note only the day, month, and year. In Germany the hour of birth is also registered. It has been recommended that in additiou to the headings given in this table the date of the marriage, the weight of the child, and what may be called the social condition of the parents, should also be recorded; but I do not know that this has been required anywhere, with the exception of the social condition, *i. e.*, comparative wealth of the parents, which may be said to have been indicated in Sweden for the ten years, 1851 to 1860, when the vital statistics of the population were given in four classes, viz, nobility, Protestant clergy, middle class, and laborers and operatives. M. Bertillon, the distinguished French statistician, who especially urges the importance of recording the social condition, proposes six classes for this purpose, *i. e.*, those receiving public charity; those maintaining themselves, but having no servant; those having one servant, two servants, three servants, and four or more servants.

In any system of registration of births a distinct definition should be given of the term still-born, which would be better phrased, *whether born dead.* A child which has lived, *i. e.*, respired after birth, should not be reported as still-born. It requires both a birth and death certificate, and the latter should state the number of hours it has lived for the first twelve hours. The period of married life at which the birth occurs appears to have some determining influence upon the sex, and it is desirable to note, therefore, the date of the marriage and the number of children which the mother has previously borne. (See Bertillon, Des modifications à introduire dans les registres de l'état civil, Bull. Soc. méd., publ. Paris, I., 1877, p. 249.) The table relating to deaths shows a general agreement as to the importance of the following items of record, viz, name, sex, age, occupation, place of birth, civil condition, legal residence, and color of the decedent; and the place, date, and cause of death. The name of the father, the maiden name of the mother, the duration of the residence, the birthplace of parents, and the date and place of burial are also required in a sufficient number of cases to mark their importance. By civil condition is meant whether single, married, or widow. A better phrase is conjugal condition. The terms nationality and race are sometimes used, but they are not satisfactory substitutes for "birthplace of parents."

Whether it would be worth while to require in addition to "birthplace of parents" the descent, meaning thereby that the person was of Irish, German, French, &c., descent, although both his parents were born in this country, may be a question. The importance, in a scientific point of view, of determining the influence of race upon vitality is very great, and the United States is the one country in the world where such observations can be best taken. But it would be difficult to define descent in such a way that the returns under this head should have the same meaning, and unless the questions were taken up by the census the information would be of comparatively small value. This will be explained hereafter.

There is much need of a systematic nomenclature of occupations for use in this country. Several attempts have been made abroad to prepare such a table, but none of them have met with general acceptance, and there is no uniformity in the reports. The best model at present is the list used in the Massachusetts report, but it is very incomplete.

The most difficult point in the registration of deaths is that relating to the cause, the report of which must be made by a competent medical man to be of any real value. Allusion has already been made to the system of verifying medical inspectors, employed in France and elsewhere. This system, however, by no means does away with the necessity of obtaining from the attending physician a statement of the cause

of death; for without this the verifying inspector would often find it extremely difficult to make out the true cause. This has been distinctly recognized in Brussels and Paris, and upon the establishment of a bureau of vital statistics in the latter city, and preparatory to publishing a weekly bulletin, the prefect of the Seine addressed a formal communication to the Academy of Medicine, requesting the co-operation of physicians in furnishing information as to the cause of death of their patients, and suggesting a method by which this could be done. The report upon this by a commission of the Academy, of which Lagneau was the reporter, forms, with the subsequent discussions, a very interesting document. (Rapport sur la co-opération des médecins traitants à la détermination des causes de décès. Bull. Acad. de méd., Paris, 1879, I ser., viii, 595.)

That good results may be obtained without the employment of verifying inspectors, is shown by the experience of England and this country. It is also possible to obtain much, although by no means complete, information as to causes of death without any special compulsory legislation as regards physicians. This was, in fact, the case during the first thirty-eight years of the English system of registration. The information as to the cause of death was obtained by the registrar in such a manner as he best could. Since 1874 more accurate information as to the cause of death is obtained from the certificates which the medical practitioners of the country are compelled to give under penalty. Under this system there is a certain number of uncertified deaths of persons who have received no medical attendance during their last illness, the number varying from about one per cent., in London, to as high as nineteen per cent. in certain parts of the kingdom.

The number of uncertified deaths depends very largely upon the number of unqualified practitioners present in a given locality, since none but a practitioner whose name is borne on the medical register, and who therefore possesses the qualifications necessary for such registration, can give a death certificate which will be accepted by the registering authorities.

Of certificates of causes of death, as usually furnished, a certain proportion are worse than useless, since the cause is erroneously stated. This may be due to a desire to conceal the true cause from the family or others, as in cases of syphilis, suicide, alcoholism acute or chronic, etc., to carelessness, erroneous diagnosis, etc. Almost every practitioner will also meet with cases in which he does not know what the cause of death was, and cannot obtain a post mortem. The first difficulty, viz, the desire to conceal the true cause from the family and friends, was the chief topic of discussion in the report of the Paris Academy of Medicine, just referred to. Incidentally, also, and as another phase of the same difficulty, the occasional disagreements in diagnosis between the verifying inspector and the practitioner are referred to, and as the interests of the latter are those especially represented by the Academy, it is natural that it should desire to protect his reputation and influence as far as possible. The plan approved by the Academy was that a copy of the report made by the inspector should be sent to the physician who had treated the case for his diagnosis.

The plan proposed by the prefect was that the physician should mail direct to the registrar a report giving the name and cause of death. It was also proposed that instead of the cause he should give a number corresponding to this cause in the official nomenclature. This plan has been long used in Brussels, and with good results. The main point is that no certificate as to cause of death, which is given to the nearest relative or the householder for transmittal, will in all cases give the cause of death accurately. This can only be secured by some system of confidential report to be sent by the physician direct to the registrar, and this is a strong reason for keeping the physician's certificate distinct from the one giving age, occupation, family relations, etc.

The second difficulty above referred to will be to some extent avoided by instructing the physician that in cases where he does not know the cause of death, and is nevertheless satisfied that it is due to natural causes, and does not require a coroner's inquest, he shall report as the cause of death apnœa or paralysis of the heart, or some similar name belonging to a group all of which the registrar will understand as being merely equivalent to "unknown."

Examination of the numerous discussions on this point which have occurred in statistical congresses shows that unless qualified physicians are employed as medical examiners the problem has been nowhere satisfactorily solved. Its difficulties appeared so great to a committee of the Royal College of Physicians of Edinburgh appointed to report on the best methods of framing public registers of deaths that they strongly advised that practitioners should content themselves with stating the seat of the disease, and whether it was acute or chronic, and not give a name to the cause of death unless they had unequivocal evidence from a post mortem or otherwise.*

All systems of mortality statistics are compiled on the principle that the number of

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* Edinb. Med. and Surg. Journ., 1841, vol. 56, p. 142.

cases of death and of causes of death must be the same. So long as this is the case it is practically impossible to give a full view of the causes of death.

If all the cases of death due immediately to renal disease are reported only under that head, many cases of scarlet fever, disease of the heart, &c., would not appear under those heads in the returns. So far as registration is concerned, all the chief concurring causes of death should be recorded. The question as to how these are to be compiled need not be discussed here.

The only other measure which seems capable of effecting any considerable improvement in this direction is the adoption of a uniform nomenclature, and this will be effectual only so far as it has educational value.

The nomenclature question has been discussed in another report. Probably the new nomenclature of the College of Physicians of London, which should soon be issued will be universally adopted in this country.

The relative merits of different forms of record books and blanks cannot be discussed here, but attention is called to the fact that each primary record should be made on a separate and distinct card, slip, or sheet of paper, and not in a book. The reason for this is that these separate slips or cards can be corrected and added to much more easily than the book record, which should contain no erasures; and furthermore, that such cards are far more easily handled than books or schedules in compiling statistics.

In estimating the relative importance of certain items in the registration of births and deaths, much will depend upon the possibility of obtaining similar or comparable information with regard to the whole living population by means of some form of census, national, state, or municipal. In other words, there should be as great correspondence as possible between the census forms and the registration forms to secure the best results in each. For example, if the census gives no information as to social condition or birthplace, these items on the registration forms lose much of their importance, although they still have a certain value.

In general it may be said that whatever information with regard to living population is called for on the census schedules, should also be required with regard to the dead. It is not proposed in this paper to consider the form in which registration statistics should be published. The registration report of Massachusetts is upon the whole at present the best model for a State annual report.

Special attention is called to the difficulty of making reliable estimates as to the number of living population in a place for any year other than a census year. This is one of the greatest obstacles to the establishment of a reliable and useful system of vital statistics upon a uniform plan throughout the country. Of the various methods in use for estimating each year the population of a city in the interval between one census and another, no one by itself can be said to give any high degree of accuracy. An interesting discussion on this point will be found in the report of Dr. Russell, medical officer of health at Glasgow. The method of estimating employed by the registrar-general of Scotland is to assume that the rate of increase as ascertained from the two immediately preceding enumerations continues the same during the course of the next ten years; each year's increment is supposed in following years to produce a proportional increase, as in compound interest, so that the aggregate at the close of the decade is greater than merely the percentage or increase calculated on the preceding census and added to the list. The method adopted by the sanitary department of Glasgow is to ascertain from the number of the houses inhabited by the census population the average number of inhabitants per house, and then in each succeeding inter-census year to apply this average as a multiplier to the inhabited houses for that year entered on the roll of the city assessor. The accuracy of the first method depends on the continuance of the rate of growth; that of the second upon the continuance of the same average number of inmates in the inhabited houses of the city.

In the case of Glasgow, taking the two estimates above referred to, and comparing them with the number actually found by the census, the result showed that both estimates were in excess of the actual population, the excess being much greater by the first method than by the second.

The truth is that there is no formula which will not lead to gross errors if strictly adhered to. The tendency is always to overestimate the number of living population. The number of deaths in a large city is in itself a means of checking such estimates, for whenever in such a city the death-rate is reported as being for a whole year less than 18 per 1,000 it may be considered as probable that either the deaths are not all reported or the population is overestimated, the latter being usually the principal source of error.

The more familiar I become with the results of registration in the United States, the more I am confirmed in the conclusions of my previous report on this subject (see National Board of Health Bulletin of February 11, 1882, vol. iii, p. 295), viz, that the General Government should take the matter in hand, and through a permanent census bureau, or through the National Board of Health, secure, by paying for them, uniform and complete registration returns from the several States.

In conclusion, I wish to express my obligations to numerous correspondents for information and suggestions on this subject, and especially to the director of the Statistical Bureau of Sweden, M. Sidenbladh; to the Medical Director of Norway, M. Dahl; to Oberstabs Artz Dr. Frölich, of Leipsig; Prof. Carl Böhm, of Vienna; Dr. Fornoni, of Milan; and to Drs. E. M. Snow, of Providence; G. P. Conn, of Concord, N. H.; F. H. Gerrish, of Portland, Me.; H. D. Fraser, of Charleston, S. C.; T. F. Wood, of Wilmington, N. C.; S. S. Herrick, of New Orleans, La.; F. W. Hatch, of Sacramento, al.; and Hon. D. H. Strother, U. S. consul general, Mexico. I am also indebted to Dr. T. J. Turner, U. S. N., for much assistance in obtaining copies of the various State acts relating to this subject.

APPENDIX.

COPIES OF REGISTRATION LAWS OF THE SEVERAL STATES, WITH NOTES AS TO RESULTS OBTAINED. ALSO, COPY OF THE ENGLISH REGISTRATION ACTS.

LIST OF STATES HAVING REGISTRATION LAWS.

Alabama.
California.
Connecticut.
Delaware.
Georgia.
Illinois.
Indiana.
Iowa.
Kentucky.
Louisiana.
Maine.
Maryland.
Massachusetts.
Michigan.
Minnesota.
New Hampshire.
New Jersey.
New York.
North Carolina.
Ohio.
Pennsylvania.
Rhode Island.
South Carolina.
Tennessee.
Vermont.
Virginia.
Wisconsin.

ALABAMA.

AN ACT to provide for the supervision of the public health and for the collection of vital statistics in the several counties of the State of Alabama.

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SEC. 5. *Be it further enacted*, That in each and every of all such counties in this State as are indicated in the first section of this act: (1.) That the county health officer shall keep a book, to be styled "the Register of Births," in which he shall register all the births that may occur in the county, under such regulations as may be from time to time prescribed by the county board of health. (2.) That in order that this registration of births may be adequately carried out, every physician, every midwife, and every other person who may attend any case of midwifery or child-birth within the limits of the county, shall make to the county health officer, and within such limit of time after its occurrence as may be from time to time prescribed by the county board of health, a full report of every such case, specifying the names of the parents, the date of the birth, and the sex and color of the child, together with such other details as may be from time to time prescribed by the county board of health. (3.) That the county health officer shall keep a book to be styled "the Register of Deaths," in which he shall register all the deaths that may occur in the county, under such regulations as may be from time to time prescribed by the county board of health. (4.) That the county health officer shall supervise all the certificates of death, to see that they are properly made out with the forms of the certificates and the nomenclature of the diseases in accordance with the requirements of the county board of health. (5.) That in all cases of death, in which no proper certificate can be otherwise obtained, the county health officer shall make out the required certificate, except that, in cases which require the intervention of the coroner, that officer shall be promptly notified. (6.) That in order that this registration of deaths may be adequately carried out, every physician, every midwife, and every other person who may have been in charge of any patient at the time of death, shall make to the county health officer, and within such limit of time after its occurrence as may be from time to time prescribed by the county board of health, a full report of every such death, specifying the name, age, sex, color, date, place, and cause of death, together with such other details as may be from time to time prescribed by the county board of health. (7.) That the county health officer shall keep a book to be styled "the Register of Infectious Diseases," in which he shall register all cases of pestilential or infectious diseases that may occur in the county, under such regulations as may be from time to time prescribed by the county board of health. (8.) That in order that this registration may be adequately carried out, every physician, and every other person practicing medicine in the county, shall make to the county health officer, and within such limit of time after its occurrence and recognition as may be from time to time prescribed by the county board of health. (9.) That every citizen or head of a family upon whose premises there may occur any case of pestilential or infectious disease,

not under the charge of any physician, shall in like manner report the facts to the county health officer.

SEC. 6. *Be it further enacted*, That in each and every of all such counties in this State as are indicated in the first section of the act: (1.) That the county board of health shall also appoint from time to time such assistant health officers, and in such numbers, and distributed in such way through the county as to them the public convenience may seem to require. (2.) That the assistant health officers shall keep severally registers of births, registers of deaths, and registers of infectious diseases of the same character as those required to be kept by the county health officers. (3.) That physicians and midwives and other citizens, may report births, deaths, and cases of pestilential or infectious diseases to any of these assistant health officers instead of to the county health officer himself whenever they find it more convenient to do so. (4.) That the same regulation that may apply, from time to time, to reports made to the county health officers shall also apply to reports made to these assistant health officers. (5.) That the assistant health officers shall make such reports of the births, the deaths, and the cases of pestilential or infectious diseases registered by them as the county board of health may from time to time prescribe. (6.) That the assistant health officers shall serve the county in the ways indicated without pay, and may be at any time summarily removed from office by the county board of health.

SEC. 7. *Be it further enacted*, That in each and every of all such counties in this State as are indicated in the first section of this act: (1.) That the county health officer shall make to the county board of health such weekly, monthly, and annual reports of all the business done in connection with his office, including the report on the sanitary condition of the county, the report of the births, deaths, and infectious diseases and such other reports as the said county board of health may from time to time prescribe. (2.) That the county board of health shall make to the board of county commissioners or the board of revenue, as the case may be, and also in duplicate to the State board of health, and during the month of January of every year, a full and complete annual report of all the sanitary work done in the county during the preceding calendar year by them or under their orders, the said annual report to contain all the vital and sanitary statistics of the county, together with such other information and suggestions and recommendations in regard to the public health as to the county board of health may seem advisable, or may be from time to time required by the board of county commissioners, or board of revenue, or by the State board of health.

SEC. 8. *Be it further enacted*, That in each and every of all such counties as are indicated in the first section of this act: (1.) That the willful failure or refusal of any physician, midwife, head of family, or other citizen, to perform any of the requirements of this act, shall be accounted a misdemeanor. (2.) That any physician, midwife, head of family, or other citizen, so willfully offending shall be punished on conviction thereof, before any court of competent jurisdiction, by a fine for each and every such offense of not less than ten dollars, nor more than fifty dollars, in the case of any physician, and of not less than five dollars nor more than twenty-five dollars in the case of any midwife, head of family, or other citizen.

SEC. 9. *Be it further enacted*, That in each and every of all such counties as are indicated in the first section of this act: (1.) That for the purpose of securing uniformity of statistical reports, the county boards of health shall execute the provisions of this act, in accordance with such regulations as may be from time to time prescribed by the State board of health. (2.) That under the provisions of this act county boards of health shall make no expenditures of money, except such as may be authorized from time to time by the board of county commissioners or board of revenue.

SEC. 10. *Be it further enacted*, That all acts and parts of acts in conflict with the provisions of this act be and are hereby repealed, and that this act shall have effect from and after its passage.

Approved February 28, 1881.

CALIFORNIA.

In response to a letter of inquiry, the following was received from Dr. F. W. Hatch, secretary of the State board of health:

SACRAMENTO, CAL., *December* 22, 1881.

Dr. J. S. BILLINGS:

DEAR SIR:

* * * * * * *

The original act relating to registration was passed by the legislature of 1871–'72. The act was published in the State board of health report for those years. Circulars were issued and blank forms distributed to the county recorders. A few responded, but the statistics were so meager and imperfect as to be useless.

* * * * * * *

When the amended act was passed I prepared new blanks for recorders, and a supply for the physicians of the State. Enough of the latter were sent to the county recorders for distribution, and circulars issued calling the attention of the profession to the importance of observing the law. As a matter of fact the law was observed by the recorders so far as the distribution of blanks and reports to this office were concerned only by those who, under the act, were to be paid for their services. Such, as you may see by section 3081 of the act, were those only whose "compensation was by *fees*." Salaried officers who, by the decision of the judiciary committee of the senate, could not receive a *fee*, even for the purposes of registration, constituting a large majority of the recorders, failed to report. But the returns of those who did report were so incomplete, in consequence of the negligence of the physicians, as to be valueless for statistical purposes.

I regret my inability to send you a copy of the act proposed at the last legislative session. The manuscript copy was placed in the hands of a member of the senate, and I have not since seen it.

It proposed to pay a small fee to physicians, midwives, &c., for each name reported, in addition to the fee previously allowed to recorders. It was objected to because the new State constitution makes all county officers *salaried*, and expressly requires all fees received to be paid into the county treasury; also that the clause providing fees for physicians was "special legislation," which is also strictly prohibited by the constitution.

An effort was made to yet further amend by ridding the bill of all matters of doubtful constitutionality, but all legislation for the remainder of the session was obstructed by contending political factions, even to the extent of adjourning without passing even a revenue bill.

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Very truly yours,

F. W. HATCH, M. D.,
Secretary State Board of Health.

[Revised Statutes.]

CHAPTER III.—REGISTRY OF BIRTHS, MARRIAGES, AND DEATHS.

SEC. 3073. All persons who perform the marriage ceremony must keep a registry of the time of each marriage so celebrated, the residence, the name in full, the place of birth, the age and condition of each party, and whether either party has ever been before married; if so, to whom, and whether the person with whom such former marriage was contracted is living or dead.

SEC. 3074. All physicians and professional midwives must keep a registry of the time of each birth at which they assist professionally, the sex and color of the child, and the names and residence of the parents.

SEC. 3075. Physicians who have attended deceased persons in their last sickness, clergymen who have officiated at a funeral, coroners who hold inquests, and sextons who have buried deceased persons, must each keep a registry of the name, age, residence, and time of death of such person.

SEC. 3076. All persons registering marriages, births, or deaths, must quarterly file with the county recorder a certified copy of their register. All such certificates must specify, as near as may be ascertained, the name in full, age, occupation, term of residence in the city or county, birthplace, condition, whether single or married, widow or widower, color, last place of residence, and cause of death of all decedents.

SEC. 3077. If at any birth no physician or midwife attends, the parents must make the report.

SEC. 3078. The recorder must * * * keep separate registers, to be known as the "Register of Marriages," "Register of Births," and the "Register of Deaths," in which the marriages, births, and deaths certified to him must be numbered in the order in which they are reported to him. There must be stated in each register, in separate columns properly headed, the various facts contained in the certificates, and the name and official or clerical position of the person making the report. The recorder must carefully examine the report and register the same marriage, birth, or death, but once, although it may be reported by different persons.

SEC. 3079. The county recorder must every three months transmit to the secretary of the State board of health at Sacramento City a certified abstract of the registers of births, marriages, and deaths, prepared in the manner prescribed in the instructions of the secretary, and upon blanks to be furnished by him for that purpose.

SEC. 3080. The persons reporting births and deaths to the recorder * * * must be primarily paid by the parents or other next of kin to the person whose marriage, birth, or death is reported, and the fee allowed by law for recording a marriage. In case no fee is paid to the person reporting a birth or death to the recorder by the

parents or next of kin of the person reported, the same must nevertheless be reported and registered, and the board of supervisors must pay from the general fund of the county a fee of not exceeding ten cents for each name reported to the person reporting and the recorder registering births and deaths.

SEC. 3081. Any person on whom a duty is imposed by this chapter who fails, neglects, or refuses to perform the same as herein required, is liable to a penalty of five hundred dollars, to be recovered by the district attorney of the proper county for the use of the general fund of such county.

CONNECTICUT.

The results of registration in Connecticut were published in annual reports of the State librarian from 1848 to 1878. After 1878 they appear in the reports of the State board of health. Prior to 1879 these reports are very incomplete. The report for 1880 gives a death rate of 16.7 per 1,000, indicating that there is still a marked deficiency in the number of deaths reported.

REGISTRATION LAWS.*

It shall be the duty of the State board of health to have the general supervision of the State system of registration of births, marriages, and deaths. Said board shall prepare the necessary methods and forms for obtaining and preserving such records, and to insure the faithful registration of the same in the several counties, and in the central bureau of vital statistics at the capital of the State. The said board of health shall recommend such forms and amendments of law as shall be deemed to be necessary for the thorough organization and efficiency of the registration of vital statistics throughout the State. The secretary of said board of health shall be the superintendent of registration of vital statistics. As supervised by the said board, the clerical duties and safe-keeping of the bureau of vital statistics thus created shall be provided for by the comptroller of the State, who shall also provide and furnish such apartments and stationery as said board shall require in the discharge of its duties. That the said board, on or before the first day of December in each year, shall make a report in writing to the governor, upon the vital statistics and the sanitary condition and prospects of the State.†

SECTION 1. Every registrar of births, marriages, and deaths shall hold office for one year from the first Monday in January next succeeding his appointment, and until his successor is appointed and qualified.

SEC. 2. The registrar shall ascertain, as accurately as he can, all the births, marriages, and deaths occurring in his town, and record the same in a book or books kept by him for that purpose, in such form and with such particulars as shall be prescribed by law. He shall give licenses to marry, according to the provisions of law, and shall make and perfect all records of the birth of any child born in his town. He shall record in the books furnished by the bureau of vital statistics such facts concerning the births, marriages, and deaths in his town as may be therein required; and he shall amend his records as he may discover omissions or mistakes therein; annually, on or before the twenty-fifth day of January, shall send the superintendent of vital statistics an attested abstract of said records for the year next preceding the first day of said January, which shall be made in such form as shall be prescribed by said superintendent, and shall deposit a true copy thereof with the town clerk.

SEC. 3. Every physician or midwife, who shall have professional charge of the mother at the birth of any child, and every attendant who may act as midwife at such a time, where no physician or midwife is employed, shall, during the first week of the month next succeeding such birth, furnish the registrar of the town wherein such birth may have taken place a certificate signed by such physician, midwife or attendant, stating, from the best information which the signer of said certificate can obtain, the facts required by the bureau of vital statistics.

AN ACT concerning the registration of births, marriages, and deaths.

SECTION 1. The registrar for completing each record of birth by inserting the full name of the child, shall receive from the town ten cents, and for ascertaining, recording, and indexing each birth of which no certificate has been furnished, fifty cents.

SEC. 2. Every physician residing without the town wherein a birth or death occurred under his charge shall make return thereof to the registrar of such town, and

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* The following provisions are compiled from the unrepealed portions of the different statutes.
† January session, 1878.

he shall receive therefor from the registrar an order on the treasurer of such town for the fee prescribed by law.

SEC. 3. No deceased person shall be buried in any town having an incorporated city within its limits until a burial permit, stating the place of burial and that the certificate of death required by law has been returned and recorded, has been given by the registrar, who upon receipt of such certificate shall issue such permit; and upon application, when permits are required, the attending physician of the deceased, and the coroner in case of an inquest, shall give such certificate; or if there be no attending physician, or his certificate cannot be obtained early enough, or where immediate burial is required, any member of the local board of health, or any physician employed to have charge of the poor of said town or city, shall give such certificate to the best of his knowledge and belief, and the registrar shall record the place of any burial other than in a public cemetery, and for each permit shall receive twenty-five cents from the town.

SEC. 4. In all towns the secretary or committee of each cemetery association shall report to the registrar of the town in which such cemetery is situated the name of the sexton at present in charge of such cemetery, and of any change hereafter.

SEC. 5. Every person having charge of any burial place shall during the first week of every month return a list, for which he shall receive fifty cents, of all the interments, disinterments, and removals made by him during the next preceding month, with the date thereof to the registrar of the town, who shall record the same in a book to be furnished by the bureau of vital statistics.

SEC. 6. Every person violating any of the provisions of this act shall be punished by a fine not exceeding twenty-five dollars.

SEC. 7. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, March 28, 1879.

AN ACT relating to returns of divorces.

SECTION 1. The returns of divorces required of clerks of the superior court to the State librarian, by section three, part sixteen, chapter one, title three, of the general statutes, shall hereafter be made to the secretary of the State board of health, which returns shall be tabulated and published in the annual report of said board.

SEC. 2. This act shall take effect from its passage.

Approved March 28, 1879.

TOWN OR CITY BY-LAWS.

Any town or city may enact by-laws, not contrary to law, more effectually to obtain a perfect registration of births, marriages, and deaths; and the registrar of the town in which such by-laws may be enacted shall execute their provisions under the same oath and penalty as if they were the statute laws of the State.

FEES.

Registrars of births, marriages, and deaths shall receive, for ascertaining and recording each birth, marriage, or death, ten cents; for issuing a certificate of license for marriage, fifty cents; for making an abstract, two dollars; for each name on such abstract over two hundred, two cents.

No person shall open any grave for the disinterment of the body of any deceased person, in any public or private cemetery or burial-place, or disinter or remove such dead body from the town in which the death took place, without having procured from the registrar a permit therefor.—Feb. 28, 1877.

DISINTERMENTS.

On the receipt by the registrar of a certificate of death, properly made in the form furnished by the superintendent of vital statistics, the registrar shall issue a permit for the disinterment or removal of the body of any deceased person, stating therein the locality of the interment, disinterment, or removal. No permit for the disinterment of the body of any deceased person during the months of June, July, August, or September shall be issued, except when required for the purposes of a legal investigation.

Every registrar of births, marriages, and deaths shall receive for issuing each permit, as herein provided, the sum of twenty-five cents.—Feb. 28, 1877.

RETURNS OF BIRTHS AND DEATHS.*

Duties of persons who shall make returns of births and deaths to the registrars.

BIRTHS.

Physicians or midwives, or any person acting as midwife at the birth of a child, should make return of the same, upon the blanks furnished by the registrar, within the first week of the month next succeeding such birth, signed by the person making the returns, stating the facts therein required from the best information which the signer can obtain. Each birth should be promptly reported, and the record of the name inserted afterwards. Parents should be instructed to report the name to the physician or registrar as soon as determined. A provision is made for a fee for the registrar on completion of an imperfect record.

DEATHS.

It is the duty of the attending physician to report on the blanks furnished by the registrar each death, with all the facts required by law. In cities, this certificate of death should be in the hands of the registrar before a burial permit is issued. There is no other way to secure complete returns of deaths in populous places than by the system of burial permits. The testimony is unanimous on this point. By reference to the bulletins of the National Health Board it will be seen that the cities which do not require a burial permit previous to interment are rapidly becoming exceptional. The attention of physicians is respectfully urged to the requirement for promptly filling out certificates of death. A little care on their part will save a great deal of unnecessary friction. If the cause of death be written in by the physician, and the certificate signed by him, the other facts can be readily filled out by the undertaker.

It is the duty of the physician to sign the certificate of death forthwith. The friends of the deceased should secure from the attending physician as soon as may be after death the certificate required by law, and furnish it to the registrar, who shall then issue the permit for burial. Proper respect for the dead demands at least that much attention be paid to their memory. The friends of the deceased are the proper persons to arrange this matter, to see that the facts concerning the last event in life, about which the State concerns itself with relation to each citizen, be correctly stated. The business and social elements involved also justify the utmost precision and care. Protection of life and prevention of crime are also involved in this transaction.

Where burial permits are not required, the physician should return the certificates of death each month to fulfill the requirements of the law. Negligence here is by far too common.

COMPENSATION.

The fee for returning the certificates of births and deaths is twenty-five cents. The penalty for violation or non-compliance with the registration laws relating to returns of births and deaths is not less than ten dollars, nor more than twenty-five dollars.

Duties of persons before whom marriages may be solemnized.

AUTHORITY AND ITS LIMITATIONS.

All judges, justices of the peace, and ordained or licensed clergymen belonging to this State, or any other State, so long as they continue in the work of the ministry, may join persons in marriage, and all marriages attempted to be celebrated by any other person shall be void; but all marriages which shall be solemnized according to the forms and usages of any religious denomination in this State shall be valid.

Marriage within certain degrees of consanguinity is by law declared void.

CERTIFICATE OF LICENSE FOR MARRIAGE REQUIRED PREVIOUSLY TO THE CEREMONY.

No clergyman or magistrate is authorized to solemnize a marriage until a certificate of license is first delivered to him, under penalty of a fine of not more than five hundred dollars, or imprisonment, one or both. The marriage license can be used only in the town where it was issued; if used in any other town, the officiating clergyman or magistrate is liable to a fine of not less than one hundred dollars, or imprisonment, one or both.

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* The following suggestions concerning the provisions of the registration laws are given in reply to questions that have been submitted.

RECORD AND RETURN REQUIRED.

Every clergyman or magistrate is required by law to return to the registrar, within the first week of the month next ensuing, the license certificates, with the fact, time, and place of each marriage certified thereon for all marriages celebrated by him during the month preceding, under a penalty of ten dollars for each omission. The certificates should be signed with name and official title.

DELAWARE.

Draft of a bill presented to the Delaware legislature in 1857, *and lost. Presented again in* 1859, *and finally passed in* 1862.

AN ACT concerning the registration of births and deaths.

SECTION 1. *Be it enacted by the senate and house of representatives in the State of Delaware in general assembly met:* That it shall be the duty of every physician in attendance of the mother of every child born in this State after the first day of January next, to file a certificate with the recorder of deeds in the county in which said birth may have taken place. Said certificate to set forth the number of the child, whether the 1st, 2nd, 3rd, &c., &c.; the sex, the color, the name of the mother, the nationality of the parents, the time and town or county in which such birth took place.

SEC. 2. *And be it further enacted as aforesaid,* That it shall be the duty of every physician in attendance upon every person who may decease in this State to file a certificate of such death with the recorder of deeds of said county in which such death may have taken place. Said certificate shall specify the name, nationality, color, sex, age, married or single, free or slave, date of death, town or county in which said death occurred, occupation, and cause of death.

SEC. 3. *And be it further enacted as aforesaid,* That it shall be the duty of every physician in attendance upon the birth of a chird or the death of a patient semi-annually in January and July (or annually) to file a certificate of all such cases, in the manner and form above provided.

SEC. 4. *And be it further enacted as aforesaid,* That if any physician as aforesaid, said, shall neglect or refuse to file such certificate, he shall be fined five dollars, to be recovered before any justice of the peace of the county in which said physician shall reside, the one-half thereof to the use of the State, and the other half thereof to the use of any one who shall sue for the same.

SEC. 5. *And be it further enacted as aforesaid,* That the recorder of deeds aforesaid in each county, shall provide a proper and suitable book or books for the registry of said births and deaths, and for the recording of said certificates. Said recorder shall be entitled to the sum of ten cents for each certificate.

SEC. 6. *And be it further enacted as aforesaid,* That the said record of births and deaths, or a duly certified copy thereof, shall be admitted as evidence in any court of law or equity, and in any proceedings whatever in this State where it may be necessary to allege and prove said birth and death: and for a certified copy thereof the said recorder of deeds shall be entitled to the sum of fifteen cents.

SEC. 7. *And be it further enacted as aforesaid,* That it shall be the duty of the recorder of deeds in each of the counties of this State to furnish an annual statement for publication, in a tabular form, of all the certificates of births and deaths received by him for the year previous to any newspaper of the county in which he resides, or if there be no such newspaper in the county, then to one in another county in this State, for publishing which a reasonable sum shall be allowed, and for the performance of said duty said recorder shall receive the sum of five dollars.

The preceding law was repealed at the next biennial session of the legislature, and no further action was taken in the matter until 1881, when the following act was passed:

AN ACT to provide for the registration of births, marriages, and deaths in the State of Delaware.

Be it enacted by the senate and house of representatives of the State of Delaware, in general assembly met, as follows:

SECTION 1. The secretary of the state of Delaware shall, on or before the first day of July, A. D. 1881, procure three suitable books for each county in the State, in which, respectively, may be recorded the births, marriages, and deaths occurring within the State, and furnish one book of each kind to the recorder of deeds in each county.

SEC. 2. It shall be the duty of said recorders to record in said books all such births, marriages, and deaths, as the same may be returned or lodged in their offices for that purpose, for which service he shall receive from the county five cents for every certificate so recorded. He shall also, at the end of every three months, furnish a copy of such records for the preceding three months to the secretary of the State board of health, for which copy he shall be paid at the same rate as above provided.

SEC. 3. The books so provided shall be separate and distinct, each from the other and shall be respectively entitled "The Register of Births," "The Register of Marriages," and "The Register of Deaths," and shall each be furnished with an index. The register of births shall be ruled on each page with columns from top to bottom, each column with an appropriate heading, as follows: Full name of child, sex, color, date and place of birth; father's name, age, occupation, nativity; name of mother previous to marriage, age, nativity; child's number in the family, number by this mother, date of certificate, date of registration (living and still born).

SEC. 4. It shall be the duty of the physician present at the birth of any child, or (if not present at the time of the birth of the child) who attends the case of any mother during her lying-in period, after the first day of July, 1881, to report to the Recorder of deeds for the county in which any such child shall have been born, the day, month, and year of the birth, the sex and color of the child, and name of the father and mother (with the other facts set forth) on the form to be furnished by the recorder of the county, and return the certificates so prepared to said recorder on the first days of January, April, July, and October in each year, together with the facts relative thereto, and every midwife present at the time of or within five days after the birth of any child, where no physician is attending said case, after the first day of July, 1881, shall, within ten days after any such birth, report to the practicing physician residing nearest her place of residence, the day, month, and year of the birth, the sex and color of the child, and the name of the father and mother (with the other facts set forth in the recorder's blanks), and the physician shall make return in the same manner as if he had been present at such birth, varying only in stating upon whose information he made the certificate, for which service the physician shall receive five cents for each certificate so returned by him, to be paid by the county in which such return has been made. Each and every birth so returned shall be registered by the recorder under the letter of the alphabet to which they respectively belong, and the birth or births therein certified shall be recorded so as to conform to the form prescribed, as far as possible, and the record need not be a literal copy, only so that it conforms to the facts certified. All certificates so returned to the recorder shall be filed by him according to the date of the return.

SEC. 5. The register of marriages shall be ruled with columns from top to bottom of each page, and have headings as follows: Full name of groom, age, color, nation or state; residence, names, and birthplaces of parents; date of marriage; number of previous marriages; name of person solemnizing the marriage; date of certificate; date of registration.

SEC. 6. It shall be the duty of every clergyman, and every magistrate, and of the clerk or keeper of the records of any religious society, by or before whom any marriage or marriages may hereafter be solemnized or contracted, to make a faithful return of the same every three months, by returning the certificate or certificates in the form issued by the secretary of state (duly filled and certified) to the recorder of deeds of the county in which such marriage or marriages may have been solemnized or contracted. If any certificate shall contain more than one marriage the recorder shall register each marriage under the letter of the alphabet to which they respectively belong, and if any certificate be not in due form, the marriage or marriages therein certified shall be registered by the recorder in such manner as to conform to the above form as far as practicable, so as to show the facts. All such certificates shall be filed according to their dates.

SEC. 7. The "register of deaths" shall on each page be ruled from top to bottom, so as to form appropriate headings as follows: Name, age, color; nation or State; if a foreigner, how long in the United States; residence, occupation, married, single, or widow; sex, name, and nation of parents; cause of death and complications, date of death, date of certificate, date of registration. Whenever any person shall die it shall be the duty of the physician attending, or of the coroner, when the case shall come under his notice, to make out under his hand and to furnish to the sexton or undertaker a certificate of said death, according to the form furnished by the recorder of deeds.

SEC. 8. No person having charge, as sexton or otherwise, of any vault or burying-ground or cemetery shall inter or allow to be interred or placed in any such vault, burying-ground, or cemetery the dead body of any person without first procuring from the physician in charge, or other authorized person, such certificate or copy thereof as prescribed in the preceding section, to be furnished by the recorder of deeds; and if there be no physician in attendance, or no coroner, then the undertaker in charge of the body, or the sexton in charge of the vault or burying-ground where

the interment will be made shall himself prepare a certificate according to the form prescribed in the preceding section; and all such certificates shall be by said sexton furnished every three months to the recorder of deeds of the county in which the death occurred. If any certificate shall contain more than one death, the recorder shall register such deaths under the letter of the alphabet to which they respectively belong, and if any certificate shall not be in due form the death or deaths therein certified shall be registered so as to conform to such form as far as practicable. In the case of the city of Wilmington, the certificate, when filled and signed as heretofore provided, shall be returned to the register of births, marriages, and deaths for that city, to be by him recorded, and returned at the end of every three months to the recorder of deeds of New Castle County, to be registered by him as above directed. It shall be the duty of the register of deaths of the city of Wilmington to publish weekly reports, in one or more of the newspapers of that city, of the number of deaths, with the diseases, and a summary of the ages of the deceased, and also specify the number of deaths from the county almshouse, and from without the city

SEC. 9. If any physician, or coroner, or sexton, or magistrate, or midwife, or register of deaths, or clergyman, or clerk of any society by or before which marriages may be solemnized, shall neglect or refuse to comply with the duties imposed on such person by the preceding sections of this act, he shall be fined not less than five nor more than ten dollars for each and every case so neglected or refused; to be recovered before any justice of the peace of the county in which said delinquent resides, the one-half thereof to the use of the State, and the other half thereof to the use of the person who shall sue for the same.

SEC. 10. The books of registration kept by the recorder, or a duly certified copy thereof, shall be admitted as evidence in any court of law or equity, and in any legal proceedings whatever in this State, where it may be necessary to allege or prove such birth, marriage, or death, the recorder of deeds shall receive the sum of thirty cents for such certificate, and fifteen cents for making a search for births, marriage, or death, to be paid by the person applying for such certificate or search, but the said register shall at all times be accessible to physicians, clergymen, and lawyers without charge.

SEC. 11. It shall be the duty of clergymen or ministers of religion of all denominations, and magistrates, and of the clerks and keepers of the records of all societies, and of all other persons by or before whom any marriage may hereafter be solemnized or contracted, and of every practicing physician and midwife, and of the register of births, marriages, and deaths, for the city of Wilmington, and of every superintendent or sexton of every cemetery or burying place, on or before the first day of July, 1881, and hereafter of all such persons as may occupy the position herein mentioned in this State, to report his, her, or their name or names and place of residence to the recorder of deeds of the county in which such person or persons may then reside, and it shall be the duty of the recorder to have the same alphabetically registered in a suitable book to be by him provided for the purpose. In the event of any of the persons above specified removing to any other place of residence, within the State, it shall be the duty of such person to notify the recorder of deeds of the county to which he removes of the fact within thirty days after such removal, and if any person, as above mentioned, shall neglect or refuse to comply with the requirements of this section, such person shall be fined not less than five dollars or more than ten dollars, to be recovered as provided in section 9.

SEC. 12. Every person who is hereby required to return a certificate of a birth, marriage, or death to the recorder of deeds or register of deaths, and shall accordingly make such return shall be entitled to receive from the levy court of the county in which birth, marriage, or death took place, the sum of five cents for each and every return so made, provided such account shall have been certified by the said recorder or register. The blank forms requisite to carry out the provisions of this act shall be furnished by the recorder of each county to each person or persons who are included in section 11, and who reside in their respective counties, and all the fees and expenses and heretofore mentioned, shall, when duly certified, be paid by the levy court of each county, except such as pertain to the city of Wilmington.

SEC. 13. All acts and parts of acts inconsistent herewith or supplied by this act are hereby repealed.

Passed at Dover, April 7, 1881.

REYNEAR WILLIAMS,
Speaker of the House of Representatives.
CATESBY F. RUST,
Speaker of the Senate.

STATE OF DELAWARE,
Executive Department.

I, James L. Wolcott, secretary of state of the State of Delaware, do hereby certify that the above and foregoing is a true and correct copy of the act entitled "An act

to provide for the registration of births, marriages, and deaths in the State of Delaware," passed at Dover, April 7, 1881, the same having been duly compared by me with the original roll now on file in my office.

In testimony whereof I have hereunto set my hand and official seal, at Dover, this thirty day of May, in the year of our Lord one thousand eight hundred and eighty-one.

[SEAL.]

JAMES L. WOLCOTT,
Secretary of State.

GEORGIA.

The act creating the State board of health in 1875 provides that the State board shall have the general supervision of the State system of registration of births, marriages, and deaths, the secretary being the superintendent of registration, and that the State board shall prepare such forms and amendments of law as shall be deemed to be necessary for the organization or efficiency of vital statistics throughout the State. All practicing physicians were required, under a penalty of $10, to report to the ordinary all deaths and births coming under their supervision, and where no physicians are in attendance the deaths shall be reported by the parents or next of kin, under penalty of $10. The ordinaries of the several counties shall record all births, marriages, and deaths, and make full and complete report of them to the secretary of the board of health.

Reports of the statistics collected under this act were published in the 1st and 2d annual reports of the board of health for the years ending October 2, 1875 and 1876—the only reports published.

In the second report the president states that the collection of vital statistics has not been successful, that the ordinaries do not appreciate the importance of the records, and in some instances have refused to perform the duty, and that those whose duty it is to report to the ordinary have also neglected their duty. He says: "It is a more or less prevalent belief that they are kept alone for some supposed benefit to the medical profession. There is another idea abroad, too, that they are solely for the use of the State board of health. * * * This great enterprise has been demonstrated to be an enterprise perhaps too far advanced in enlightenment for the progress of the age in the State of Georgia. It has been found, as entrusted to the board itself, to bring this body in unpleasant conflict with the medical profession of the State, and to excite antagonisms which are injurious to the interests of registration, and specially to the more legitimate objects of the board. We propose, therefore, that the duty of the collection of vital statistics be committed to some other department of the State government."

In January, 1876, the law was so amended that so much of the act as required the physician to report under penalties of $10 was repealed; also so much as imposes a penalty of $10 on parents was repealed, and that for making record of births and deaths, the ordinary shall receive 5 cents for each person so registered.

This practically put an end to registration in the State of Georgia.

AN ACT to create a State board of health for the protection of life and health, and to prevent the spread of disease in the State of Georgia, and for other purposes. Passed at regular session in January and February, 1875.

SECTION 1. *The general assembly of the State of Georgia do enact*, That within ninety days after the passage of this act the governor shall appoint nine physicians of skill and experience, who shall have been regular graduates of medicine and practitioners of not less than ten years, one from each Congressional district in the State, who, for the time being, shall be sanitary commissioners for the said districts, and the said sanitary commissioners, together with the comptroller-general, and attorney-general, and State geologist, shall constitute a board of health, to be called the board of health of the State of Georgia; five members of which, at any regular, called, or adjourned meeting, shall constitute a quorum for the transaction of business.

SEC. 2. *Be it further enacted*, That the said nine physicians so appointed shall hold office as such sanitary commissioners, respectively, for the terms following, namely, three for two years, three for four years, and three for six years, and until their successors are appointed and qualified. After the appointment of said nine physicians, as aforesaid, they shall meet in the office of the secretary of state, upon notice from him of the day of meeting, and shall proceed, under his direction, to determine, by lot, which of them shall hold for the respective terms of two, four, and six years the said office of sanitary commissioners. Immediately, and before entering upon the duties of the office, they shall take the oath prescribed for State officers by the constitution of the State, and shall file the same in the office of the secretary of state, who, upon receiv-

ing the said oath of office, shall issue to each of said commissioners a certificate of appointment for his respective term of office, so determined as aforesaid; upon receiving which they shall severally be and become sanitary commissioners, and shall possess and exercise the power and perform the duties of said board as defined in this act.

SEC. 3. *Be it further enacted*, That the term of office of said sanitary commissioners, after the expiration of the terms aforesaid, shall be six years, and they shall be appointed by the governor. Any vacancies that may occur, by reason of death, removal from office, or otherwise, shall be filled in like manner.

SEC. 4. *Be it further enacted*, That immediately after the nine appointed sanitary commissioners shall have taken the oath of office, as above provided, they shall meet with the attorney-general, the comptroller-general, and the state geologist and organize as a board of health by electing one of said board to be president, and by appointing a proper person, who shall be a physician, to be secretary of said board, and the successive presidents of said board of health shall be annually elected by said board from the members thereof. The secretary shall continue in office, as such, until removed by the election of a successor, or otherwise, and be executive officer of said board, and shall receive an annual salary not to exceed one thousand dollars. The sanitary commissioners shall receive no salary, but the actual personal expenses of any member, while engaged in the duties of the board, shall be allowed and paid.

SEC. 5. *Be it further enacted*, That said board shall take cognizance of the interests of life and health among the people of the State; they shall make inquiries in respect to the cause of diseases, and especially of epidemics, and investigate the sources of mortality, and the effects of localities, employments, and other conditions upon the public health.

SEC. 6. *Be it further enacted*, That it shall be the duty of said board to obtain, collect, and preserve such information relating to deaths, diseases, and health, as may be useful in the discharge of its duties, and contribute to the promotion of the health, or the security of life, in the State of Georgia; and it shall be the duty of all health officers, and boards of health in the State to communicate to said State board of health copies of all their reports and publications; also, such sanitary information as may be useful; and said board shall keep record of its acts and proceedings as a board; and it shall promptly cause all proper information in possession of said board to be sent to the local health authorities of any city, village, or town in the State which may request the same, and shall add thereto such useful suggestions as the experience of said board may supply; and it is hereby made the duty of said health authorities to supply like information and suggestions to said State board of health; and said State board of health is authorized to require reports and information (at such times, and of such facts, and generally of such nature and extent, relating to the safety of life and the promotion of health, as its by-laws or rules may provide) from all public dispensaries, hospitals, asylums, prisons, and schools, and from the managers, principals, and officers thereof; and from all other public institutions, their officers and managers, and from the proprietors, managers, lessees, and occupants of all places of public resort in the State; but such reports and information shall only be required concerning matters and particulars in respect of which it may, in its opinion, need information for the proper discharge of its duties. Said board shall, when requested by public authorities, or when they deem it best, advise officers of the State, county or local governments, in regard to sanitary drainage, and the location, drainage, ventilation, and sanitary provisions of any public institution, building, or public place.

SEC. 7. *Be it further enacted*, That it shall be the duty of the State board to give all information that may reasonably be requested concerning any threatened danger to the public health, to the health officers of the ports of Savannah, Darien, Brunswick, and St. Mary's, and to the commissioners of quarantine of said ports, and all other sanitary authorities in the State, who shall give the like information to said board; and said board and said officers, said quarantine commissioners and sanitary authorities shall, as far as legal and practicable, co-operate to prevent the spread of diseases and for the protection of life and the promotion of health within the sphere of their respective duties.

SEC. 8. *Be it further enacted*, That it shall be the duty of the State board to have the general supervision of the State system of registration of births, marriages, and deaths; the said board shall recommend such forms and amendments of law as shall be deemed to be necessary for the thorough organization and efficiency of registration of vital statistics throughout the State; the secretary of said board shall be the superintendent of registration of vital statistics as revised by said board; the clerical duties and safe keeping of the bureau of vital statistics thus created shall be provided for by the comptroller-general of the State, who shall also provide and furnish such apartments and stationery as said board shall require in the discharge of its duties.

SEC. 9. *Be it further enacted*, That it shall be the duty of said board, on or before the first Monday in December of each year, to make a report, in writing, to the governor of this State, who shall lay the same before the next general assembly thereafter,

upon the vital statistics and sanitary condition and prospects of the State; and such report shall set forth the action of said board, of its officers and agents, and the names thereof for the past year, and may contain other useful information, and shall suggest any further legislative action or precaution deemed proper for the protection of life and health.

SEC. 10. *Be it further enacted*, That said board shall meet at least every twelve months, and may also hold special meetings as frequently as the proper discharge of its duties shall require; the same to be convened by order of the president, and the rules or by-laws shall provide for the giving of proper notice of all such meetings to the members of the board.

SEC. 11. *Be it further enacted*, That all physicians in the practice of medicine in this State shall be required, under penalty of ten dollars, to be recovered in any court of competent jurisdiction in the State, at the suit of the ordinary (the amount so recovered to be appropriated to a special fund for the carrying out the objects of this law), to report to the ordinary, in the forms to be provided, all deaths and births which may come under his supervision, with a certificate of the cause of death, &c.

SEC. 12. *Be it further enacted*, That where any birth or death shall take place, no physician being in attendance, the same shall be reported to the ordinary, with the supposed cause of death, by the parents, or if none, by the next of kin, under penalty of ten dollars, at the suit of the ordinary, as provided in section eleven of this act.

SEC. 13. *Be it further enacted*, That the coroners of the several counties shall be required to report to the ordinary all cases of death which may come under their supervision, with the cause and mode of death, &c., under the penalty of ten dollars, the same to be recovered and the proceeds applied as in section eleven of this act.

SEC. 14. *Be it further enacted*, That the ordinaries of the several counties in the State shall be required to keep separate books to record all births, marriages, and deaths which take place in their counties. Said books shall always be open to the inspection of the public without fee. And the said ordinaries shall be required to render a full and complete report of all such births, marriages, and deaths to the secretary of the board of health, at such time or times as the said board may direct.

SEC. 15. *Be it further enacted*, That it shall be the duty of the said board of health to prepare such forms for reports of births and deaths as they may deem proper, the said forms to be furnished by the secretary of said board to the ordinaries of the several counties, whose duty it shall be to distribute them to such persons as are required by this act to make such reports.

SEC. 16. *Be it further enacted*, That the sum of fifteen hundred dollars is hereby appropriated for the purposes of this act, to be drawn by the warrant of the governor as occasion may require, upon proper certificate and vouchers of the said board.

SEC. 17. *Be it further enacted*, That nothing in this act contained shall be construed to be in conflict with the two existing medical boards of the State of Georgia.

SEC. 18. Repeals conflicting laws.

ILLINOIS.

AN ACT to create and establish a board of health in the State of Illinois, approved May 25, 1877.

* * * * * * *

SEC. 3. The board of health shall have supervision of the State system of registration of births and deaths, as hereinafter provided; they shall make up such forms and recommend such legislation as shall be deemed necessary for the thorough registration of vital and mortuary statistics throughout the State. The secretary of the board shall be superintendent of such registration. The clerical duties and the safe keeping of the bureau of vital statistics thus created shall be provided by the secretary of state.

SEC. 4. It shall be the duty of all physicians and accouchers in this State to register their names and post-office address with the county clerk of the county where they reside; and said physicians and accoucheurs shall be required, under penalty of ten dollars, to be recovered in any court of competent jurisdiction in the State, at suit of the county clerk, to report to the county clerk, within thirty days from date of their occurence, all births and deaths which may come under their supervision, with a certificate of the cause of death, and such correlative facts as the board may require, in the blank forms furnished, as hereinafter provided.

SEC. 5. Where any birth or death shall take place, no physician or accoucheur being in attendance, the same shall be reported to the county clerk within thirty days from the date of their occurrence, with the supposed cause of death, by the parent, or if none, by the nearest of kin, not a minor, or if none, by the resident householder where the death shall occur, under penalty as provided in preceding section of this act.

SEC. 6. The coroner of the several counties shall be required to report to the county clerk all cases of death which may come under their supervision, with the

cause and mode of death, &c., as per forms furnished, under penalty as provided in section four (4) of this act.

SEC. 7. All amounts received under the penalties herein provided shall be appropriated to a special fund for the carrying out the object of this law.

SEC. 8. The county clerks of the several counties in the State shall be required to keep separate books for the registration of the names and post-office address of physicians and accoucheurs, for births, for marriages, and for deaths; said books shall always be open to inspection without fee, and said county clerks shall be required to render a full and complete report of all births, marriages, and deaths to the secretary of the board of health annually, and at such other times as the board may direct.

SEC. 9. It shall be the duty of the board of health to prepare such forms for the record of births, marriages, and deaths as they may deem proper; the said forms to be furnished by the secretary of said board to the county clerks of the several counties, whose duty it shall be to furnish them to such persons as are herein required to make reports.

* * * * * * *

REGISTER OF MARRIAGES.

1.	2.	3.	4.	5.
1. Number of license. 2. Date of license....	1. By whom affidavit, if any, is made. 2. By whom consent to marriage given.	1. Full name of groom. 2. Place of residence. 3. Occupation	1. Age next birth day. 2. Race or color .. 3. Place of birth.	1. Father's name. 2. Mother's maiden name. 3. Number of groom's marriage.

6.	7.	8.	9.	10.
1. Full name of bride. 2. Maiden name, if widow. 3. Place of residence.	1. Age next birth day. 2. Race or color .. 3. Place of birth ..	1. Father's name. 2. Mother's maiden name. 3. Number of bride's marriage.	1. Where and when married. 2. Witnesses ..... 3. By whom certified; name and office.	1. Date of return. 2. When registered.

REGISTER OF BIRTHS.

No.	Date of return.	1. Name of child; 2. Sex; 3. Number of children of this mother.	Race or color.	1. Date of birth; 2. Place of birth.

Age.	1. Nationality of mother; 2. Place of birth.	Age.	1. Full name of mother; 2. Maiden name of mother; 3. Residence of mother.	1. Full name of father; 2. Occupation.	1. Name and address of medical attendant; 2. Name and address of person making certificate; 3. Returned by.

REGISTER OF DEATHS.

No.	Date of report.	1. Name; 2. Sex and color.	1. Age; 2. Occupation.	Date of death.			
				Month.	Day.	Year.	A. m. or p. m.

Single, married, widower, or widow.	1. Nationality; 2. Where born.	How long resident in this State. Years.	1. Place of death; 2. Cause of death.	1. Complication; 2. Duration of complication; 3. Duration of disease.

1. Place of burial; 2. Date of burial.	1. Name of undertaker; 2. Place of business.	Name and residence of physician returning certificate.

ILLINOIS STATE BOARD OF HEALTH. NO. 102.

OFFICE OF THE SECRETARY,
Springfield, July 15, 1882.

DEAR SIR: At a regular meeting of the State board of health, held April 13–15, 1882, the following resolution was adopted:

Resolved, That, in order to protect the legal interests of survivors, to facilitate the detection of crime, and to secure fuller and more accurate knowledge of the causes of mortality, whereby preventive medicine and general sanitation may be promoted, the Illinois State board of health earnestly recommends to the proper authorities of all cities and towns in this State, having populations of one thousand or over, the enactment and enforcement of a suitable ordinance requiring a burial permit from a designated official, and based upon the physician's certificate of death *now required by the statute*, as a condition precedent to interment within, or removal of a decedent without, the corporate limits of any such city or town.

A form of such ordinance is herewith presented, and it is hoped you may be able to secure its enactment.

It should be observed that wherever such an ordinance is adopted the certifying physician is relieved of the necessity of transmitting his certificates direct to the county clerk, but will simply return them to the designated city or town official, who will forward them to the county clerk after using them as the basis for the burial permit. This has been found to work well practically in places where burial permits are required. It helps to secure a more general compliance with the law requiring physicians to report all deaths occurring under their supervision, with certificates of the causes thereof.

The manifest object of the State law is to secure such knowledge of the causes of

mortality as may lead to measures for removing or modifying such causes as are susceptible of removal or modification. This is of primary importance to cities and towns, since a reputation for healthfulness or the reverse undoubtedly influences the growth and prosperity of any given locality. By means of the burial permit and its record the facts contained in the physician's certificate may be made immediately available for this purpose, while they cannot be where returned direct to the county clerk. From the "suitable book," prescribed in section 4 of the ordinance, a weekly or monthly report may be compiled for publication, either in the newspaper press or otherwise, and thus the condition of, and the influences affecting, the public health may be accurately judged at any given time, and comparison made with other localities.

Where burial permits are required—as they are in many places—the existence of a contagious disease—as small-pox, scarlet fever, diphtheria—has often first been made known by the information given in the permit, which thus serves to direct preventive measures for arresting further spread of the contagion.

On the other hand, in the absence of a burial permit many evils arise, among which may be mentioned the fact that the bodies of murdered persons may be more easily disposed of. Within a very brief period three such instances have come to the secretary's knowledge where the bodies of the victims were buried without exciting suspicion. Accidental clews lead to disinterment and discovery of the crimes.

Briefly, the reasons for the enactment of such an ordinance may be thus summarized:

First. It will be of value in securing fuller, more accurate, and more readily available knowledge of the causes of death—a knowledge which is absolutely necessary to the profitable application of efforts for the preservation of health, the limitation of disease, and the prolongation of human life.

Second. It will be of value in the protection of life against criminal violence, by facilitating the detection of such violence through preventing the burial of victims of homicide, abortion, poisoning, &c., without proper investigation.

Third. It will be of value in the protection of property interests by making the facts pertaining to a death and burial matters of record, which may be useful in probating wills, settling estates, determining heirships, perfecting letters, adjusting life insurance, and kindred matters.

For the foregoing reasons your interest and influence in behalf of the measure are confidently anticipated.

Very respectfully,

JOHN H. RAUCH, M. D.,
Secretary.

To ——— ———, Esq., M. D.,
———— ————.

S. B. H. No. 103.

AN ORDINANCE in relation to burial permits.

Be it ordained by the ——— of the ——— of ——— in the county of ——— in the State of Illinois:

1. That no burial or interment shall be lawful in the ——— of ———, nor shall any dead body be removed from said ———, until a permit for such burial, interment, or removal shall have been first obtained from the ——— of said ———.

2. That such permit shall be issued by the ——— upon his receipt of the usual certificate of death, signed by (1) the attending physician in the case; or, if none, by (2) one of the parents of the deceased; or, if none, by (3) the nearest of kin not a minor; or, if none, by (4) the resident householder where the death occurred; or, if none, by (5) any reputable citizen cognizant of the facts and circumstances of the death; or, if the death be subject of an inquest, by (6) the coroner or other officer holding said inquest.

3. That any undertaker or sexton, and each and every other person engaged or concerned in a burial in violation of the provisions of this ordinance, and the officers and employés of any transportation company, or any other person or persons engaged or concerned in the removal of a dead body from said ——— in violation of the provisions of this ordinance, shall be subject to a fine of not less than ——— (——) dollars, nor more than ——— (——) dollars for each offense.

4. That the ——— shall enter in a suitable book, to be kept for that purpose, a record of all burial permits issued, specifying the date of issue and to whom issued, together with all the items of information contained in the certificates upon which the issue of such permits is based; and he shall forward to the county clerk of ——— county, at the end of each month all of said certificates so received during the month.

5. That this ordinance shall be in force from and after its passage and approval.

INDIANA.

By the act establishing the State board of health, approved March 7, 1881, it is provided that any physician, accoucheur, coroner, or householder, after notice by the board, failing or refusing to comply with the provisions of this section 10 shall be guilty of a misdemeanor, &c.

Section 10 provides that all physicians and accoucheurs shall report to the secretary of the board of health of the town, city, or county in which they may occur, and within fifteen days thereafter all births and deaths occurring under their supervision, with a certificate of the cause of death and such facts as required in the blank forms furnished. In the absence of a physician or accoucheur such birth or death shall be reported by the householder.

The State board of health has the power to order local boards to promulgate and enforce rules relative to the preservation of public health.

It has also been decided that a physician or accoucheur who receives blanks from the State board of health is notified under the terms of the law.

CIRCULAR L.

INDIANA STATE BOARD OF HEALTH,
SECRETARY'S OFFICE,
Indianapolis, January 10, 1882.

County Board of Health of —— County:

DEAR SIRS: In order to secure uniformity and accuracy, I have prepared *forms* for quarterly reports of county boards of health to the State board of health of deaths, births, diseases, and marriages. Also for monthly reports of local boards of health of cities and towns to county boards of health of deaths, births, and diseases. Upon requisition of county boards of health to the State board such quarterly reports will be furnished, and through them monthly reports to local boards of health of cities and towns: *provided*, that no requisition will be filled for any *form* of such reports in counties that have not adopted such *forms* or complied with the "instructions of the State board of health." Such "instructions" are as follows, viz:

1. Each county board shall, upon making requisition for quarterly reports, have its health officer to certify that the *forms* contained in the requisitions have been adopted by such county board, and that such board will proceed to collect such statistics provided for in such *forms* "according to the instruction of and as required by the State board" in 3 (note) and other parts of this circular.

2. The requisition for *forms* for monthly reports for the boards of cities and towns of any county shall contain the same certified stipulations from health officers of each city and town board the requisition is made for as is required (in 1) for the county health officer. In no other way can these forms be obtained except upon requisition of the health officer of each county upon the State board, and "under instructions from said board, except at the expense of local boards."*

3. NOTE.—All *forms*, except those for monthly and quarterly reports of *births*, *deaths*, *and marriage* (quarterly), are *optional* with the county board of health. They *may adopt* forms (6) and (12) (diseases) or not, as they desire. If they adopt them and send the requisition as above instructed, we will furnish *forms* (6) and (12) (diseases) quarterly and monthly. We hope that upon receipt of this each county health officer will promptly see the health officer of each city and town in his county and arrange as to what they wish, as provided above. Requisitions can be made out—but the full instruction being carefully *complied with* for quarterly or monthly reports for the kind of *form* adopted and mentioned, *provided* that in no case will the county or local health officer receive upon any requisition more than two (2) monthly reports of each form and one (1) quarterly—and no second requisition will be accepted or filled until the *forms* already sent shall have been returned filled to this department. The State board distinctly states it will in *no case* furnish or provide for any record, blanks, circulars, or other material used by physicians, accoucheurs, boards of health, &c., except the monthly and quarterly reports above mentioned, and according to the "instructions and the direction" above and herein named, and also state that all *blanks*, *records*, stationery, or other material that in the opinion of such county board (or city or town board) may be thought necessary for obtaining such statistics for filling the form of reports mentioned in the requisition shall be furnished by such county (or city or town) board, and at their expense; and under instructions from the State board of health the local boards shall from this date furnish such material as they *may deem proper* to boards of health of cities and towns and persons resident of such county, to enable them to make proper record and report of such statistics they shall elect to collect, and that the county, city, and town boards, respectively, shall furnish such material as they may deem proper to any person resident of such county, city, or town to enable them to make proper report of such statistics that the county, or State board, through the county board, may elect.

Monthly and quarterly reports will commence February 1, 1882.

NOTE.—In circular (C) it is ordered that "*the county health officer*, after correcting his reports by comparison with the small blanks, shall return such in a package to this department." This portion of the *rule* as to return is withdrawn; such *small blanks* are to be kept by the county health officer for comparison, and filed for at least the space of *one year* from the time of filing them.

4. *Form* (10), monthly return of marriage can be adopted at the option of each county health board. It is suggested that such a *form* would greatly aid the county health officer, but it is left to his own discretion and order of county board. Blanks of *form* (10) will not be furnished by this department.

5. *Form* (10) for the return of marriages by the county clerk, and form (E) (circular) are not ordered by this department, but specimen issued for the consideration and action of county health officers and clerks. The county health officer is by law (see Sec. 12) compelled to keep a record of marriages according to *forms* prescribed by this board; but it is to be understood that the *form* thus prescribed cannot be kept *in full* unless the form (3) is filled out and returned for use of county health officer. The county clerk is, by Sec. 11, compelled to keep a record of certain facts, viz, the number of certificates issued, the names of the parties, and the dates of such marriage, and report to county health officer; and if in the opinion, *but at the option*, of the county board, it is necessary for the purpose of enabling the county officer to more efficiently perform his work, they can issue, at the *expense of the county board*, such form (10) and circular (E). All circulars or blanks issued by local boards, in accordance with forms issued by this board or otherwise, shall be at the expense of such local board. All records kept by local boards shall be furnished at the expense of such boards.

From and after this date the several local boards of cities and towns will hold official communication with their several county boards of health and health officers alone.

NOTE.—The local boards of cities and towns are in all cases supplied with the report named by or through county boards. No other *course is legal*. No *form* except those for *births, deaths, and marriage are mandatory*. *Form* of report of "Disease" (quarterly and monthly) if adopted with the above "instructions," will be furnished in accordance therewith. The *record similar* to Form (2) is, however, *mandatory*.

Each county health officer is hereby directed to collect from the several health boards of cities and towns in such county the name of the health officer of such boards, and if none are elected to order such election and report the same to this department.

**Every requisition to be honored must contain the words*, "in accordance with the instructions and conditions in Circular L."

NOTE.—An *accoucheur* is not recognized by the act creating the State board of health as a *physician*. Such must report *birth* and *death*, but cannot give certificate of vaccination.

NOTE.—Records of marriages *must be kept* by county health officers similar to *Form* (2); also, records of *all forms* adopted. The issuing of *Form* (3) is *obligatory*, and at the expense of each county board. The specimen of each *form* herewith specified and sent must be credited upon the first requisition.

THAD. M. STEVENS,
Secretary State Board of Health.

IOWA.

[Act approved March 26, 1880.]

* * * * * * *

SEC. 2. The State board of health shall have the general supervision of the interests of the health and life of the citizens of the State. They shall have charge of all matters pertaining to quarantine; they shall supervise a State registration of marriages, births, and deaths, as hereinafter provided; they shall have authority to make such rules and regulations and such sanitary investigations as they may, from time to time, deem necessary for the preservation or improvement of the public health; and it shall be the duty of all police officers, sheriffs, constables, and all other officers of the State to enforce such rules and regulations, so far as the efficiency and success of the board may depend upon their official co-operation.

SEC. 3. The clerk of the district and circuit courts of each of the several counties in the State shall be required to keep separate books for the registration of the names and post-office address of physicians and midwives, for births, for marriages, and for deaths, which record shall show the names, date of birth, death, or marriage; the names of the parents and sex of the child when a birth, and when a death, shall give the age, sex, and cause of death, with the date of the record, and the name of the person furnishing the information. Said books shall always be open for inspection without fee; and the clerks of said courts shall be required to render a full and com-

plete report of all births, marriages, and deaths to the secretary of the board of health annually, on the first day of October of each year, and at such other times as the board may direct.

SEC. 4. It shall be the duty of the board of health to prepare such forms for the record of births, marriages, and deaths as they may deem proper; the said forms to be furnished by the secretary of said board to the clerks of the district and circuit courts of the several counties, whose duty it shall be to furnish them to such persons as are herein required to make reports.

SEC. 5. It shall be the duty of all physicians and midwives in this State to register their names and post-office address with the clerk of the district and circuit courts of the county where they reside; and said physicians and midwives shall be required under penalty of ten dollars ($10), to be recovered in any court of competent judisdiction in the State, at suit of the clerk of the courts, to report to the clerk of the courts, within thirty (30) days from the date of their occurrence, all births and deaths which may come under their supervision, with a certificate of the cause of the death, and such other facts as the board may require, in the blank forms furnished, as hereinafter provided.

SEC. 6. When any birth or death shall take place, no physician or midwife being in attendance, the same shall be reported by the parent to the clerk of the district and circuit courts within thirty (30) days from the date of its occurrence, and if a death, the supposed cause of death, or, if there be no parent, by the nearest of kin not a minor, or, if none, by the resident householder where the birth or death shall have occurred, under penalty provided in the preceding section of this act. Clerks of the district and circuit courts shall annually, on the first day of October of each year, send to the secretary of the State board of health a statement of all births and deaths recorded in their offices for the year preceding said date, under a penalty of twenty-five dollars ($25) in case of failure.

By an act of March 18, 1882, it is provided that the clerk of the district and circuit courts "shall receive, in addition to the compensation already allowed him by law (meaning merely his salary), the sum of ten (10) cents for each birth, marriage, or death so recorded by him, and the further sum of ten (10) cents for each one hundred (100) words of written matter contained in said report, the same to be paid out of the county fund."

KENTUCKY.

On the organization of the State government the law of Virginia as to marriages was adopted. This required that to enable a minister or magistrate to solemnize a marriage he must have authority from the county court for solemnizing it, and must return to the clerk the license with his own certificate of the date of the marriage. This law, says Dr. Sutton, was very poorly executed. In some counties the only evidence of the marriage was that the bond had been given upon which the license had been granted, but there was no record that the marriage had ever taken place. Even in the best counties there was no return to show that from one-third to one-half the parties to whom licenses had been granted had been actually married. The first law on the subject was passed in 1851, and is as follows:

[Revised Statutes, pages 546 to 548, inclusive.]

SECTION 1. That it shall be the duty of all clergymen or other persons, who shall hereafter celebrate or perform the marriage ceremony within this commonwealth, to keep a registry of all marriages celebrated by them, showing the names, ages, residence, and place of birth of the persons married, whether they were single or widowed, and the time of the marriage.

SEC. 2. It shall be the duty of all physicians, surgeons, and midwives, to keep a registry of all births and deaths at which they have professionally attended, showing in cases of births the time and place of birth, name of the father, and maiden name of the mother, and their residence, sex, and color of the child, together with its name, if it shall receive one, and whether it was born alive or dead; and showing in cases of death, the time, place, and cause of death, the name, age, sex, color, and condition (whether single, married, or widowed), name and surname of parents, occupation, residence, and place of birth of the deceased: *Provided*, That in case of a birth of a slave, the name of the owner shall be given in place of the names of the parents, and, in case of the death of a slave, the owner's name may be given in place of the condition, occupation, and residence: *And provided further*, That when two or more physicians, surgeons, or midwives may have attended professionally at any birth or death, that physician, surgeon, or midwfe who is oldest in attendance shall make the registry.

SEC. 3. It shall be the duty of clergymen, physicians, &c., above named to deposit in the county clerk's office of the counties in which such births, &c., occur, on or before the tenth day of January in every year, the said registry, or a copy thereof, embracing the period of one year, ending on the thirty-first day of December last preceding the time of deposit, and the clerk shall deliver copies of the same to the assessor.

SEC. 4. It shall be the duty of the assessors, while making their lists of taxable property, to ascertain and record in a list separate from the list of taxable property all the births, marriages, and deaths which shall have occurred within their respective counties in the twelve months ending on the thirty-first day of December last preceding the time of assessment, with all the items of time, place, &c., herein directed to be inserted in the registries above named; and they shall make strict inquiry of all heads of families, and shall use the registries of clergymen, &c., above named, in order to obtain correctly the information herein required. They shall return said lists of births, &c., with the registries of clergymen, &c., aforesaid, to the clerks of the county courts at the same time they return their lists of taxable property; and the clerks shall copy said lists of births, &c., and transmit the copies to the auditor of public accounts, with the list of taxable property. The clerks shall be paid at the same rates they are paid for copying the list of taxable property. The assessor shall be allowed two cents for each birth, marriage, or death recorded as herein directed, to be paid in the same manner as for making the lists of taxable property: *Provided*, That it shall be lawful for any assessor to record separately the time, place, &c., of any birth, marriage, or death which may have occurred prior to the time which the list then being made embraces, or which may have occurred without this commonwealth. For every entry so made the party causing it to be done shall pay the assessor two cents.

SEC. 5. It shall be the duty of the auditor to make, from all the lists of births, marriages, and deaths so transmitted to him, tabular statements showing, in a condensed form, the information herein required to be preserved, keeping the statistics of each county separate, and to cause five hundred copies of the same to be printed in pamphlet form, on or before the first day of January in every year; to transmit not more than five nor less than two copies to each county court clerk's office in this commonwealth, one of which shall be forever carefully kept in such office, and the remainder distributed for the use of the citizens of their respective counties. He shall cause to be printed suitable blanks for the use of assessors, clergymen, physicians, &c., with separate columns for each of the items of information herein required, and send a sufficient number of said blanks to the clerks of each county court for distribution. He shall annex to said blanks such instructions as he may deem necessary to secure the faithful execution of this act.

SEC. 6. To enable the assessors to obtain full and correct information touching the facts herein required to be ascertained, they shall have full power to swear and interrogate any person in their respective counties for that purpose; and it shall be the duty of all such persons, when thereto required by the assessor, with or without oath, to give him, fully and truly, all the information he or she may possess touching any of said facts.

SEC. 7. The several county court clerks shall forever carefully preserve the lists of births, &c., and the registries of clergymen, &c., herein required to be returned to them for the use of the public.

SEC. 8. The said lists of births, marriages, and deaths, returned to the clerks of the county courts by the assessors, as also the original tabular record herein required to be made and kept by the auditor, or a duly certified copy of any birth, marriage, or death from either of them, given and certified by the keeper of such records, shall hereafter be admitted and received in all courts in this commonwealth as *prima facie* evidence of any such birth, marriage, or death therein recorded or so certified.

SEC. 9. Any person failing to discharge and perform any of the acts and duties herein imposed and required to be done, shall for every such failure be fined in a sum not less than five nor more than twenty dollars, to be recovered by warrant before a justice of the peace, or by presentment by the grand jury.

In 1878 an act was passed creating a State board of health, the 10th section of which is as follows:

"The secretary of the State board of health shall be the superintendent of vital statistics. Under the general direction of the auditor he shall collect these statistics, and prepare and publish the report required by law relating to births, deaths, and marriages."

LOUISIANA.

The legislation relating to registration in this State, commencing with the territorial act of 1811, is shown in the following pages. At present there is practically no registration outside the parish of Orleans, as the statutes expressly provide that no

person out of that parish shall be under any legal obligation to have a birth or death recorded.

The peculiarity of the registration system in the parish of Orleans is that the person who makes the declaration of birth, death, or marriage must pay a fee to the health office. This is probably one cause of a defective registration of births, especially among the colored population.

ACTS OF LOUISIANA, 1811.

CHAPTER XX.—AN ACT to provide for the recording of births and deaths.

SECTION 1. *Be it enacted by the legislative council and house of representatives of the Territory of Orleans in general assembly convened*, That it shall be the duty of all the parish judges of this Territory (except the parish judge of New Orleans, to be hereafter provided for) to record all the births of white persons on a book bound and kept for that purpose by order of dates, and likewise to record all deaths of white persons on another book kept in the same manner.

SEC. 2. *And be it further enacted*, That it shall be the duty of the parish judges to receive declarations of births within eight days from the birth, and that they may, however, extend that delay to three months after the birth, when a declaration could not be made sooner on account of the persons, who are to make the same, living at a distance or being prevented so to do by sickness or other lawful impediment.

SEC. 3. *And be it further enacted*, That the birth of a child shall be declared by his father, or in case the father could not make the said declaration, by any other person who may have been present at the birth of the child, and that the said birth shall be immediately recorded in the presence of two witnesses.

SEC. 4. *And be it further enacted*, That the said records shall contain the day, hour, and place of birth, the sex of the child, and the first name or names given to the child, the first name or names, profession and residence of the father and mother, and the name of the witnesses.

SEC. 5. *And be it further enacted*, That deaths shall be recorded by the parish judges upon the declaration of two witnesses; those two witnesses shall be, if possible, the two nearest relations or neighbors of the deceased, or, when a person shall have died out of his or her house, the person at whose house he or she shall have died, with a relation or another.

SEC. 6. *And be it further enacted*, That the records of deaths shall contain the first names, name, age, trade, and residence of the deceased, the first names and name of the surviving consort, if the person deceased was married, or a widower, or a widow, the first names and name, age, profession, and residence of the declarants, and if they be relations, their degree of relationship. The same record shall contain, as far as the same may be ascertained, the Christian names, name, profession, and residence of the father and mother of the deceased, and the place of his or her birth.

SEC. 7. *And be it further enacted*, That for the parish of Orleans there shall be for the city of New Orleans an office of records of births and deaths, whereof the officer shall be appointed by the governor.

SEC. 8. *And be it further enacted*, That the keeper of the office of records of births and deaths in New Orleans, and the parish judges of this Territory, shall receive the following compensation for duties imposed upon them by this act:

For every record of birth and death	50 cents.
For registering or copying of the same with the seal	50 cents.

SEC. 9. *And be it further enacted*, That there shall be kept for the recording of births and deaths of free people of color, books similar to those which shall be kept for white persons, in conformity with this act, and that the formalities above prescribed concerning white persons shall be observed with respect to people of color.

Approved April 10, 1811.

AN ACT supplementary to an act entitled "An act to provide for the recording of births and deaths," passed on the 10th April, 1811.

Whereas the act to which this is a supplement has not been carried into execution until this day, because it does not contain any provision to make it a duty to those whom it concerns to present themselves before the parish judges and the officer who has in charge the office of records of births and deaths in New Orleans:

SEC. 1. *Be it enacted by the senate and house of representatives of the State of Louisiana in general assembly convened*, That after the passage of this act the birth of every free child in the parish of New Orleans shall be declared therein within thirty days. This declaration shall be made conformably to the third section of the act to which this is a supplement, and every person offending against the provisions of the said section

shall pay a fine not exceeding ten dollars and not less than five dollars, half of which shall be for the benefit of the State, and the other half for the benefit of the informer.

SEC. 2. *And be it further enacted*, That the death of every free person within the parish of New Orleans shall be declared therein within thirty days; that this declaration shall be made by the nearest relations of the deceased, if they are present, and in case of absence, by the testamentary executor, if there is one; if none, by the owner or tenant of the house in which the individual will have died.

And every person offending against the provisions of this section shall be fined in a sum not exceeding ten dollars nor less than five dollars.

SEC. 3. *And be it further enacted*, That in lieu of the compensation which is allowed by the eighth section of the act to which this is a supplement, for every record of, birth and death and for registering the same, henceforward a sum of fifty cents shall be allowed.

Approved March 6, 1819.

LAWS OF LOUISIANA, 1820, 1821, 1822.

AN ACT to validate certain marriages celebrated in this State, and for other purposes.

Whereas in several parishes of this State doubts have arisen as to the validity of certain marriages celebrated by the parish judges, under the impression those judges were, that they had the power as well as the justices of the peace to celebrate marriages; and whereas it is important to society to put an end to those doubts:

SEC. 1. *Be it enacted by the senate and house of representatives of the State of Louisiana in general assembly convened*, That all marriages heretofore celebrated in this State by any of the parish judges thereof be, and the same are hereby declared, legal and valid, so far as relates to the ceremony of the marriages and the authority of the person who performed the same: *Provided*, however, That the said marriages have been contracted agreeably to the laws of the land in other respects.

SEC. 2. *And be it further enacted*, That the parish judges of this State shall in future have the authority to celebrate marriages after the expiration of the same delays that are now provided for by law for the said judges to grant licenses to justices of the peace to contract the same, all laws to the contrary notwithstanding.

Approved March 11, 1820.

LAWS OF LOUISIANA, 1845.

No. 104.

AN ACT supplementary to the several acts relative to the celebrations of marriages.

SECTION 1. *Be it enacted by the senate and house of representatives of the State of Louisiana, in general assembly convened:* That from and after the first day of May, eighteen hundred and forty-five, no minister of the gospel or magistrate shall be authorized to celebrate marriages in this State, who shall not previously have obtained a written special license to that purpose, to him directed by the parish judge of the parish where he has his domicil.

SEC. 2. *Be it further enacted, &c.*, That any minister of the gospel not resident of the parish before obtaining from the parish judge a special license, as aforesaid, to celebrate marriages shall give bond in the office of the parish judge in the sum of two thousand dollars, with two securities, residents of the parish where the bond is executed, conditioned that the said minister of the gospel conform in all respects with the laws of the State concerning marriages.

SEC. 3. *Be it further enacted, &c.*, That it shall be the duty of any minister of the gospel or magistrate who shall celebrate a marriage, to make duplicate acts of the celebration signed by himself, by the parties and three witnesses as required by law, one of which acts he shall return within a delay of thirty days, to the parish judge, who shall file and record the same in his office.

SEC. 4. *Be it further enacted, &c.*, That the act entitled "An act amendatory of the several acts concerning the celebration of marriages," approved twenty-seventh March, eighteen hundred and forty-three, be and the same is hereby amended so far as it is inconsistent with this act; *Provided*, that any alien minister of the gospel may celebrate marriages when so authorized by a special permit of the parish judge, and after having complied with the requisitions of this law.

SEC. 5. *Be it further enacted, &c.*, That all violations of any of the provisions of this act shall be punished by fine not exceeding one thousand dollars, and it shall be the duty of the district attorneys to prosecute all such violations before any competent tribunal.

SEC. 6. *Be it further enacted, &c.*, That all laws or parts of laws contrary to this act be and the same are hereby repealed.

Approved March 10, 1845.

[From Revised Statutes of La., 1870.]

SEC. 338. It shall be the duty of all the parish recorders of this State to record all births in a book bound and kept for that purpose in the order of their dates.

SEC. 339. It shall be the duty of the parish recorder to receive declarations of birth within 8 days from the birth. They may, however, extend that delay to two months after the birth, when a declaration could not be made sooner, on account of the persons who are to make the same living at a distance, or being prevented by sickness or other lawful impediment.

SEC. 340. The birth of a child shall be declared by his father, or in case the father could not make the said declaration, by any other person who may have been present at the birth of the child, and the said birth shall be immediately recorded in presence of the two witnesses.

SEC. 341. The said records shall contain the day, hour, and place of birth, the sex of the child, and the first name or names given to the child, the first name or names, profession, and residence of the father and mother, and the names of the witnesses.

SEC. 342. Deaths shall be recorded by the parish recorders, upon the declaration of two witnesses, who shall be, if possible, the two nearest relatives or neighbors of the deceased, or when a person shall have died out of his house, the person at whose house he shall have died, with a relation or another.

SEC. 343. The record of deaths shall contain the name in full, age, trade, and residence of the deceased, the name in full of the surviving consort, if the person deceased was married, or a widower, or a widow, the name, age, profession, and residence of the declarants, and if they be relatives, their degree of relationship. The same record shall contain, as far as the same may be ascertained, the Christian names, profession, and residence of the father and mother of the deceased, and the place of his or her birth.

SEC. 344. No person out of the parish of Orleans shall be under any legal obligation to have a birth or death recorded.

SEC. 345. The birth of every child in the parish of Orleans shall be declared therein within 30 days, as provided in the preceding sections. Every person offending against the provisions of this section shall pay a fine of not less than 5 nor more than 10 dollars, one-half for the benefit of the informer.

SEC. 346. For the parish of Orleans there shall be an office of recorder of births and deaths, whereof the officer shall be appointed by the governor.

SEC. 347. The death of every person within the parish of Orleans shall be reported at said office within 24 hours thereafter. This declaration shall be made by the nearest relative of the deceased, if he or she is present, and in case of absence, by the testamentary executor if there be one; if there be none, by the owner or tenant of the house in which the person died, and if the death happened in a State, parish, municipal, charitable or benevolent institution, hospital, asylum, prison, work-house, house of refuge, insane asylum, etc., it shall be the duty of the president, superintendent, or managers of said institutions to have the said death recorded in the said office of births and deaths monthly. It shall also be the duty of the coroners to record monthly in said office the deaths of all persons upon whose bodies an inquest has been held or a certificate issued by them for the burial of indigent persons, and the recording fees in such cases shall be charged to the city of N. Orleans or the police jury of the parish of Orleans, right bank, as the case may be, and any person contravening the provisions of this section shall be fined not less than 10 nor more than 25 dollars, recoverable before any court of competent jurisdiction.

SEC. 348. For every record of birth and death and for registering the same, henceforward the sum of 50 cents shall be allowed.

[Extract from act of 1877.]

SEC. 8. *Be it further enacted, etc.*, That the president of said board be *ex officio* recorder of births, deaths, and marriages for the parish of Orleans, but shall, as such, be under the general direction and control of said board. All fees collected by him shall be paid into and be a part of the funds of said board. The said board shall prescribe such blanks and forms as it may deem necessary for procuring vital statistics in said parish, and enforce the use of the same, and the president of said board shall cause to be prepared and shall keep suitable books of record for said office, which shall be carefully preserved in fire-proof buildings or vaults.

SEC. 9. *Be it further enacted, &c.*, That it shall be the duty of the attending physician or midwife, at the birth of any child in the parish of Orleans, to report the same to the office of the board of health within twenty-four hours of the same, and it shall be the duty of the father, or, in his default, of any person present at the birth of any child to report within twenty-four hours from the date of said birth at the office of the board of health such birth, which report shall be recorded in presence of two witnesses, and shall as nearly as possible show the date, hour, street, and number thereof of such birth, the sex of the child and its name, the names of the father and

mother, their nationality, age, occupation, and residence, and the name of said witness.

SEC. 10. *Be it further enacted, &c.*, That every death in the parish of Orleans shall be reported at said office within twenty-four hours after it has occurred; such report shall be made by the nearest relative or the husband or wife of the deceased if present in the parish; otherwise by the executor, if designated, or landlord of the deceased, or the officiating undertaker. It shall be the duty of coroners to report all deaths coming to their official notice, and of the president, manager, or superintendent of any State, parish, municipal, charitable or benevolent institutions; said report shall contain, as far as possible, the full name, sex, age, occupation, residence, color, or race and nativity of the deceased, the cause of the death, the street, and number where it occurred; shall show whether the deceased was married or unmarried, the name of surviving spouse if any, and where residing; also the name, age, and residence of the declarant, and his relationship, if any, to the deceased, and such other particulars as may be required by said board. No body shall be removed from said parish until a permit shall have been obtained from the president of said board under his official seal, showing that the requirements of this section have been complied with.

SEC. 11. *Be it further enacted, &c.*, That every marriage celebrated in the parish of Orleans shall be recorded in said office; such record shall show the full names of the contracting parties, their age, nativity, date of license of marriage and by whom issued, the names of the parents or tutors of the contracting parties, the name of the officer, priest, or ecclesiastic celebrating the marriage, with the date of its celebration and the names of the witnesses thereto, and any such facts as the board may judge necessary for vital statistics. It shall be the duty of the officer, priest, or ecclesiastic celebrating any marriage to return the license authorizing such marriage to said office after having indorsed on such license the date of such celebration; these licenses so returned shall be preserved among the papers of said board.

SEC. 12. *Be it further enacted, &c.*, That it shall be the duty of the president of said board to cause the registry of any marriage celebrated prior to the passage of this act, on production of a certificate duly attested of the celebration of such marriage; and in case of the loss of such original certificate, such registry shall be made on the production of the affidavits of the contracting parties, and at least one of the witnesses present, or of the officer, priest, or ecclesiastic celebrating such marriage, and a certified copy of such registry shall be *prima facie* evidence of such marriage.

SEC. 13. *Be it further enacted, &c.*, That there shall be collected for the recording, under this act, of any birth or death the sum of fifty cents, and like fee for any certificate of such record, and for recording any marriage, the sum of one dollar, and like fee for certificate of the recording of the same.

(Approved, April 20, 1877.)

MAINE.

PORTLAND, *December* 12, 1881.

DEAR SIR: Your esteemed favor of the 8th instant was duly received, and with the aid of a legal friend, I am enabled to answer your several inquiries concerning vital statistics.

The State of Maine was set off from Massachusetts in 1820, and the statute which was the earliest predecessor of our existing law is of date "February 28, 1821," and reads as follows:

"AN ACT for recording births and deaths by the clerks of towns."

"SECTION 1. *Be it enacted by the senate and house of representatives in legislature assembled*, That it shall be the duty of every town clerk within this State to record all births and deaths which shall happen within his town and come to his knowledge, together with the time of such birth or death and the names of his or her parents, if known, for fees allowed by law, to be paid by his town.

"SECTION 2. *Be it further enacted*, That it shall be the duty of parents to give notice to the clerk of the town in which they dwell of all births and deaths of their children; and it shall be the duty of every householder to give notice of every birth and death which may happen in his house; and of the eldest person next of kin to give such notice of the death of his kindred; and it shall be the duty of the master or keeper of any almshouse, workhouse or prison, and of the master or commander of any ship or vessel to give notice of every birth or death which may happen in the house or vessel under his care or charge, to the clerk of the town in which such event shall happen; and in case any person whose duty it shall be by virtue of this act to give notice aforesaid, shall neglect to perform the same for the space of six months after the birth or death shall happen, the person so neglecting shall pay a fine of one dollar, to be

recovered with costs of suit, on complaint before any justice of the peace for the same county, to the use of any inhabitant of the same town who shall prosecute for the same."

In all probability this law was copied (as were most of our Maine statutes in the beginning) from that of Massachusetts. In 1840 an amendment was inserted by virtue of which the fine of one dollar, instead of going to the complainant, was to be recovered for the use of the town.

By an amendment, which was approved on the 25th of February, 1865, the town clerk was required to keep a copy of the returns of births and deaths "in a book kept for that purpose," and "on or before the second Monday of May annually make duly certified returns thereof to the secretary of state for each year ending with the last day of March." These returns were to be filed by the secretary in his office. No further change was made until the revision of 1871, and you already have sections 20, 21, 22 of chapter 59—all the law relating to this matter.

With regard to the records of marriages, &c., I find that by the act approved 19th February, 1821, people wishing to marry were obliged to publish their intentions in public religious meeting thrice at intervals of at least three days, or else have their intentions posted up by the town clerk for fourteen days, and to show the person whom they desired to marry them the town clerk's certificate of their lawful publication. The consent of parents was required in case of minors.

In April of each year justices and ministers were required to make returns to the town clerk of the names of all persons joined in marriage by them, and all who neglected to do this were liable to a fine of fifty dollars, one-half going to the county and the other to the person suing.

By the amended act of 1865 (already referred to) solemnizers of matrimony are still required to make returns, but are apparently relieved of all penalty for non-performance.

It is in this act (1865) that I find the first mention of assessors as gatherers of information concerning births and deaths. Their duties and the penalties for neglect, &c., are there prescribed substantially as in the law of which you have a copy.

2. There are no blanks, forms, or notifications of births, marriages and deaths to be filled out by individuals.

3. The original law concerning intentions of marriage has been modified, so that now five days' notice must be given to the town clerk; at the end of that time he may deliver a certificate of the fact, which paper the marrying justice or minister must see. Minors and paupers are not allowed to be married, excepting the former, who may have their intentions published, if their parents permit.

4. There are no publications among the State documents relating to these statistics, and, furthermore, there is great laxity and frequent, not to say general, non-compliance with the law in this respect.

5. The assessors in some places do gather some statistics. The data are as follows: Name of child, date of birth, names of parents.

* * * * * * *

Very respectfully yours,

FREDERIC HENRY GERRISH, M. D.

MARYLAND.

The first law on registration adopted by the State of Maryland was passed in 1865, and is given below. It has been almost absolutely inoperative, its chief effect being to supplement the compensation of the secretary of state. The act of 1880 reconstructing the State board of health makes the secretary of the board the superintendent of vital statistics. The only record of marriages in the State is the record licenses issued by the clerks of the county courts.

[Revised Statutes, p. 269, 1878.]

TITLE XIX.

ART. 30.—*Registration of births, marriages, and deaths.*

1. The clerks of the circuit courts of the several counties, and the clerk of the court of common pleas of Baltimore City, shall receive and record in books prepared for the purpose the following facts concerning the births, marriages, and deaths in said county or city, separately numbering and recording the same in the order in which he receives them, designating in separate columns—

First. In the record book of births, the date of the birth, the place of birth, the

name of the child (if it have any), the sex and color of the child, the names of the parents, the occupation of the father, the residence of the parents, and the date of the record.

Second. In the record book of marriages, the name, residence, age, color, condition (whether single, widow, or widower), and occupation of each of the parties, with the date of record; which said particulars, with the exception of the date of record, shall be ascertained and inserted in the body of the marriage license by the clerk issuing the same, & at the time thereof, and the date, place of marriage, name, residence, and official station or title of the person solemnizing it, shall be duly stated or certified on the back of said license by the person thus solemnizing it, & the return thereof made as hereinafter provided; and for all of which said particulars suitable blank forms shall be furnished by the comptroller of the treasury to such clerks.

Third. In the record book of deaths, the date of the death, the name of the deceased, the sex, the color, the condition (whether single, widowed, or married), the age, the residence, the occupation, the place of death, the place of birth, the names & place of residence of the parents, the disease or cause of death, the place of burial, and the date of record.

2. The said record books provided for by the preceding section shall be truly & regularly paged, and alphabetically indexed, in the case of births, with the name of the child (if it have a name), and if it have no name, then with the name of the father, if its mother be a married woman, & if its mother be unmarried, then with the name of the mother, in the case of marriages with the names of both parties to said marriage, and in the case of deaths with the name of deceased, or if said deceased be an infant without a name, then with the name of the father or mother of said deceased infant.

3. Parents shall give notice of the facts herein required to the clerk of the court aforesaid, of the county or city in which a birth or death may take place; every householder shall give such notice of every birth and death happening in his house; the eldest person next of kin shall give notice of the death of his kindred; the keeper of a prison, hospital, almshouse or other public institution, shall give notice of every birth and death happening among the persons under his charge; the person solemnizing or performing the marriage ceremony shall give such notice; any such person neglecting or refusing to give such notice for the space of six months after a birth, marriage, or death, shall forfeit and pay a sum not exceeding five dollars.

4. Any physician having attended a person during his or her last illness, shall when requested, within fifteen days after the decease of such person, forthwith furnish information of the duration of the last sickness, the disease of which the person died or cause of death, and the date of the decease as nearly as he can state the same.

5. Every sexton, coroner, undertaker or other person, having charge of the obsequies or funeral rites, preliminary to the interment of the body of a stranger or friendless person, shall forthwith obtain and return to the clerk aforesaid of the county or city in which the deceased resided or the death occurred, the facts required by this act to be recorded, by said officer concerning the deceased; any person neglecting or refusing to make such return within one month thereafter shall forfeit and pay a sum not exceeding ten dollars.

6. The notice required to be furnished by sections 3 and 5 according to section one, may for greater convenience be deposited with any justice of the peace residing in the election district wherein the birth, marriage or death takes place, and it shall be the duty of the said justices of the peace to transmit the same to said clerk every three months.

7. The clerk of the court aforesaid shall annually on or before the first day of January transmit to the secretary of the senate certified copies of the records of the births, marriages, and deaths which shall have occurred in said county or city during the year ending on the 31st of December preceding.

8. The records of the clerks of said courts relative to any births, marriages, or deaths shall be *prima facie* evidence in legal proceedings of the facts recorded; the certificate signed by said clerk, with the seal of his office affixed thereto, shall be admissable as evidence of any such record.

9. The clerk aforesaid shall receive from his county or city for obtaining, recording, indexing, and returning to the secretary of the senate the facts in relation to a birth, marriage, or death, 15 cents for each case rendered, as the same shall be certified by the secretary of the senate; he shall forfeit and pay a sum not less than 20 nor more than 50 dollars for each refusal or neglect to perform any duty required of him by this act.

10. The secretary of the senate shall at the expense of the State, prepare & furnish to the several clerks of the counties and the city of Baltimore aforesaid, blank books of suitable size and quality, to be used as books of record and indexes thereto under the provisions of this act, and blank forms for returns on paper of uniform size, and shall accompany the same with such instructions and explanations as may be necessary and useful.

11. The secretary of the senate shall cause the returns received by him for each year to be bound together in one volume, with the index thereto; he shall prepare from the returns such tabular results as will render them of practical utility, & report thereof to each regular session of the legislature, & do all other things necessary to carry into effect the provisions of this act; he shall enforce by suit in the name of the State the recovery of the forfeits or penalties prescribed in section 9 of this act, & he shall receive for the performance of the duties imposed by this act the sum of one thousand dollars per annum. In case of a vacancy occurring in this office by death, resignation, or otherwise, the vacancy shall be filled by the governor until a successor shall be elected and qualified.

12. It shall be the duties of the clerks for the respective counties and the city of Baltimore to enforce by suit, in the name of the State, the recovery of the forfeitures and penalties imposed by sections 3 and 5 of this act.

MASSACHUSETTS.

The history of registration in the United States begins with Massachusetts, as will be seen by the following records and copies of acts, and the results obtained and published in that State have been more complete and satisfactory than in any other up to the present time. Thirty-nine annual reports relating to the registry and return of births, marriages, and deaths in the commonwealth have now been published under the direction of the secretary of the commonwealth, the last being for the year 1880. The first of these reports, however, interesting as they are, are nevertheless incomplete, and it has only been within the last two or three years, or since the passage of the act approved in 1878, requiring a burial certificate in every case, that anything like complete returns have been secured.

I am informed by Dr. Folsom, who for several years has been charged with the editing of these reports, that as regards deaths they are now very complete, and he estimates the deficiency at not more than 1 per cent.

Records of the Colony of the Massachusetts Bay, in New England.

A general court, holden at Boston, the 4th day of September, 1639.

ITEM: That there be records kept of all wills, administrations, and inventories, as also of the days of every marriage, birth, and death of every person within their jurisdiction.

For every death, 1*d.*; for every birth, a 1*d.*; the same to be certified once every year at the time of the general court, the same party bringing the certificates to pay the fees unto the recorder for entry of the same, and such towns to be fined 40*s.* as shall fail to send up their certificates.

A general court held at Boston the 7th of March, 1644.

Whereas the order for the recording of deaths, births, and marriages is very useful and necessary, and yet it hath been in many places much neglected, it is ordered that all parents, masters of servants, executors, and administrators, respectively, shall stand charged to bring in to the clerks of the writs the names of such, belonging to them, or to any of them, as shall either be born or die, and that the new married man shall stand likewise bound to bring in a certificate of his marriage, under the hand of that magistrate which married him, to the clerk of the writs, who shall, under the penalty of twenty shillings, bring a certificate under his hand, with a penny a name, as well for the recording of marriages as the rest; and for each neglect the person to whom it doth belong shall forfeit as follows, viz: If any person shall neglect to bring in a note, or certificate, as aforesaid, together with three pence a name, to the said clerk of the writs, to be recorded above one month after such birth, death, or marriage, he shall then pay six pence to the said clerk; if he neglect two months, twelve pence; if three months, five shillings, which forfeit shall be returned into the treasury; also, we think it were meet the grand juries were minded to present such defaulters as they take notice of against the intent of this order.

Plymouth Colony records.

At a general court, 20th October, 1646.

It is enacted by the court that there shall be in every town within this government a clerk or some one appointed and ordained to keep a register of the day and year of the marriage, birth, and burial of every man, woman, and child within their township,

and to have 3*d.* apiece for each particular person so registered; and further, it is enacted that every father or mother, or next in relation, shall certify to the town clerk or register keeper the name and day of the birth of every child so born in his house, within one month after it is born, or be fined for every such default three shillings, the one half moiety thereof to the governor, the other half moiety thereof unto the said clerk, or register keeper, upon his complaint; and that every person married shall signify his and her name, with the day upon which they were married, unto the said clerk or register keeper within one month next after the day of his said marriage, upon the like penalty of 3*s.*, the one moiety thereof unto the governor's use, and the other unto the said clerk or register keeper, upon his complaint. And also that every master or mistress of the family in which any person dies, or person next in relation to any person so dead, shall give notice unto the said clerk or register keeper the name of the person and day of the said burial, subpœna, 3*s.*, the one half or moiety to the governor's use, the other to the clerk or register keeper, upon his complaint; and the clerk or register keeper of each township shall exhibit a true and perfect copy, fairly written, annually at March court unto the said court, of all the births, marriages, and burials of the year past; and, lastly, that the clerk or register keeper in every township shall publish all contracts of marriages, and shall have 12*d.* as his fee for every marriage as he publisheth orderly.

In the Plymouth Colony laws of 1658 the above was re-enacted, with an amendment by which half of the fines went to the government instead of the governor.

At a session of the general court, at Boston, May 6th, 1657.

This court, taking into their consideration the great damage that will unavoidably accrue to the posterity of this commonwealth by the general neglect of observing the law enjoining of records of all births, deaths, etc., do therefore order that henceforth the clerk of the writs in each town respectively take due care for effecting the same, according to the intent of the aforesaid law; and in case any person or persons shall neglect their duty required by the said law more than one month after any birth, death, or marriage, the clerk of the writs shall demand the same, with 12*d.* a name for his care and pains; and in case any shall refuse to satisfy him he shall then return the name of such person or persons to the next magistrate or commissioners of the town where such person dwells, who shall send for that party so refusing, and in case he shall still persist therein, shall give order to the constable to levy the same; and if any clerk of the writs shall neglect his duty hereby enjoined, he shall pay the following penalty, viz: For neglect of a yearly return to the county court, 5 *li.;* and for neglecting to return the name of any person returnable by this law, whether born, married, or dead, more than 30 days before his return to the county court, 5*s.* And that no future neglect may be herein, the recorder of each county court is hereby enjoined from time to time to certify the county courts, respectively, the names of all such clerks as shall neglect to make their yearly return according to this law, who, upon notice duly given, shall send for such clerk, and deal in the case according as law requireth.

Laws of the Province of Massachusetts Bay.

1692–3.

CHAPTER 48.—AN ACT for the registring of births and deaths.

For preventing of great uncertainty and inconvenience that may happen for want of a particular register of births and deaths—

Be it enacted, etc., That every town clerk within this province shall be and is hereby impowred and required to take an account of all persons that shall be born, or shall die, within each town, respectively, and the precincts thereof, and fairly to register in a book their names and surnames, as also the names and surnames of their parents, with the time of their birth and death. And the clerk shall demand and receive the fee of three pence, and no more, for each birth or death by him so registred, to be paid by the parents or others nextly related to or concerned with the party born or dying. And if any shall refuse or neglect to give notice to the town clerk of the birth or death of any person that they are so related to or concerned for, or to pay for registring, as above said, by the space of thirty days next after such birth or death, every person so refusing or neglecting, and being (upon the complaint of any town clerk) thereof convicted before a justice of the peace within the same county, shall forfeit and pay unto such clerk the sum of five shillings, to be levied by distress and sale of the offender's goods by warrant from such justice, if payment thereof be not made within four days next after conviction as aforesaid. And every town clerk shall

give forth from the registry a fair certificate, under his hand, of persons born or dying in the town, to any who shall desire the same, and he shall receive six pence and no more for every certificate so given.

Passed Feb. 17, 1693.

CHAPTER 25.—AN ACT for the orderly consummation of marriages.

SEC. 3. And every justice and minister shall keep a particular register of all marriages solemnized before any of them, and make a return thereof at the end of each quarter of a year unto the clerk of the sessions of the peace within the same county, to be by him registered; who is hereby impowred thereto, and shall be paid by every such justice & minister three pence for each marriage so returned.

Passed Nov. 3, 1692.

1695.

CHAPTER 2, SEC. 6. And all marriages shall be registered by the town clerk of the same town where they are consummated; and every justice or minister, as aforesaid, shall return a note or certificate unto the clerk of the town of the names of all persons whom they shall marry, and of the time when, within three months at farthest, after consummation of the same, and shall allow and pay out of his fee unto the clerk for entring the same three pence, any law, usage or custom to the contrary notwithstanding.

Passed June 22, 1695.

1716.

CHAPTER 16, SEC. 2. That every justice or minister shall have four shillings for each marriage, and pay out of it six pence to the town clerk when they return their certificates to him.

And whereas there is great failure in returning certificates of marriages to the town clerk—

Be it enacted [Section 3.] That each justice of the peace or minister neglecting to make due return to the town clerk, as the law directs, every of them shall pay a fine of ten shillings for such neglect.

SEC. 4. That every town clerk shall give in a true list of all marriages returned to him by the justices and ministers respectively, unto the clerk of the sessions of the peace in each county, some time in the month of April yearly, and every year, under penalty of forfeiting twenty shillings fine for every neglect. And every town clerk shall pay two pence to the clerk of the peace for every marriage returned by him, as aforesaid, which shall be the fee for the clerk of the peace, his recording the same. And each fine is to be recovered by bill, plaint, or information in any court of record.

1742.

CHAPTER 5.—AN ACT for establishing and better regulating fees within this province.

* * * * * * *

For each marriage, two shillings and six pence; whereof to be paid to the town clerk, six pence. * * *

Recording births and deaths, each four pence.

For a certificate of the birth or death of any person, three pence.

1743.

CHAPTER 10.—AN ACT for establishing and regulating fees within this province.

* * * * * * *

For each marriage, two shillings and six pence; out of which to be paid to the town clerk for recording, three pence; and to the clerk of the sessions for recording, three pence.

(Other fees same as before.)

1750.

CHAPTER 8.—AN ACT for establishing and regulating fees of the several officers within this province, as are hereinafter mentioned.

* * * * * * *

For each marriage to the minister or justice officiating, four shillings. For recording it: to the town clerk, to be paid by the justice or minister, four pence; and to the clerk of the the sessions, to be paid by the town clerk, two pence.

Recording births and deaths, each two pence.

For a certificate of the birth or death of any person, three pence.

Laws of the Commonwealth of Massachusetts.

1786.

AN ACT for the orderly solemnization of marriages. [Passed June 22, 1786.]

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SEC. 6. *And be it further enacted*, That every justice and minister shall make and keep a particular record of all marriages solemnized before them respectively; and in the month of April, yearly, and every year, shall make a return to the clerk of the town, district, or plantation in which he lives, certifying the names (both Christian names and surnames) of all the persons who have been by them respectively joined together in marriage within the year then last past, if any such have been by them so joined together. [And if it shall so happen that any one or more of the said justices or ministers shall not have joined together in marriage any persons during the course of the year then last past, it shall be the duty of such justice or minister also to certify to the said town clerk, in writing, under his hand, that he has not joined any persons in marriage within the course of the said year.*] And if any justice or minister shall neglect to make such returns within the month of April, annually, the clerk of the town, district, or plantation where such delinquent justice or minister lives, shall, without delay, certify such neglect to the clerk of the court of general sessions of the peace of the same county, who shall lay the same before the said court at their next session; and the person so neglecting shall be cited to appear before said court, to answer for such neglect; and if no sufficient reason shall be assigned therefor, he shall be considered and adjudged disqualified for joining persons in marriage for a term of time, not exceeding ten years, at the discretion of the justices of the said court. And every town and district clerk shall duly and seasonably record all marriages, so certified to him, as aforesaid, and shall also return a list or copy thereof to the clerk of the court of general sessions of the peace of the same county, some time in the month of May, yearly and in every year, to be there recorded, upon penalty of forfeiting twenty shillings for each neglect. And it shall be the duty of each clerk of the sessions to prosecute for every such neglect, in the county to which he belongs. And every clerk of the sessions shall record all such returns of marriages at large in a book to be kept for that purpose, and no other, under the same penalty for each neglect.

Laws of the Commonwealth of Massachusetts.

1796.

AN ACT establishing and regulating the fees of the several officers and other persons hereafter mentioned, and for repealing the laws heretofore made for that purpose.

* * * * * * *

FOR MARRIAGES.

To the town clerk for publishing the banns of matrimony, recording the same, giving a certificate of the publishment, and recording the marriage upon receiving the justice's or minister's certificate thereof, fifty cents, to be paid by the man published on receiving a certificate of the publishment.

And the town clerk shall not in future be holden to return certificates of marriages to the clerks of the courts of general sessions of the peace, nor clerks last mentioned to record the same.

To every minister or justice of the peace, who shall lawfully solemnize a marriage, and certify the same, one dollar and twenty-five cents.

To the town clerk for recording births and deaths, eight cents each. For a certificate of a birth or death, ten cents.

Passed Feb. 13, 1796.

AN ACT for recording births and deaths by the clerks of towns and districts.

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SECTION 1. *Be it enacted, etc.*, That it shall be the duty of every town clerk and every district clerk, within this commonwealth, to record all births and deaths which shall happen within his town or district and come to his knowledge, together with

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* Clause in brackets repealed June 15, 1795.

the time of such birth or death, and the names of his or her parents, if known; for the fees allowed by law, to be paid by his town or district.

SEC. 2. *And be it further enacted*, That it shall be the duty of parents to give notice to the clerk of the town or district in which they dwell, of all the births and deaths of their children; and it shall be the duty of every householder to give notice of every birth and death which may happen in his house; and of the eldest person next of kin to give such notice of the death of his kindred; and it shall be the duty of the master or keeper of any almshouse, workhouse, or prison, and of the master or commander of any ship or vessel, to give notice of every birth or death which may happen in the house or vessel under his care or charge, to the clerk of the town or district in which such event shall happen. And in case any person, whose duty it shall be by virtue of this act, to give notice as aforesaid, shall neglect to perform the same for the space of six months after the birth or death shall happen, the person so neglecting shall pay a fine of one dollar, to be recovered, with costs of suit, on complaint before any justice of the peace for the same county, to the use of any inhabitant of the same town who shall prosecute for the same, from which judgment there shall be no appeal

1834.

CHAPTER 177.—AN ACT for the orderly solemnization of marriages.

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SEC. 5. *Be it further enacted*, That every justice and minister shall make and keep a particular record of all the marriages solemnized before them respectively, and in the month of April, annually, shall make a return to the clerk of the city, town, or district in which he resides, of a certificate containing the Christian and surnames, and places of residence, of all the persons joined in marriage by them respectively, within the years then last past, and also the time when, and the name of the city, town, or district, in wkich such marriages were respectively solemnized; and when neither of the persons married belongs to, or is resident in the city, town, or district in which such justice or minister resides, then such justice or minister shall also make a like return of a certificate to the clerk of the city, town, or district in which one or both of the persons married may reside, within thirty days from the solemnization of the same. And any justice or minister who shall neglect to make such returns shall, upon conviction thereof, before any court of competent jurisdiction, in the county in which he resides, forfeit and pay for each neglect a sum of not less than twenty nor more than one hundred dollars, at the discretion of said court, one moiety thereof to the use of said county, and the other moiety to the use of the person who shall prosecute for the same; and every city, town, or district clerk shall duly and seasonably record all marriages so certified to him as aforesaid.

Passed April 1, 1834.

1842.

CHAPTER 95.—AN ACT relating to the registry and returns of births, marriages, and deaths.

Be it enacted by the senate and house of representatives in general court assembled, and by the authority of the same, as follows:

SECTION 1. The clerks of the several towns and cities in the commonwealth shall, annually in the month of May, transmit to the secretary of the commonwealth a certified copy of their record of the births, marriages, and deaths of all persons within their respective towns and cities which may come to their knowledge; shall state the number of births and marriages and the number of deaths, with the name, sex, age, (and if an adult male, the occupation), and the names of the diseases of which all persons have died, or are supposed to have died, together with the cause or causes of the death of all such deceased persons, so far as they may be able to obtain a knowledge of the same from physicians or others; and any clerk who shall neglect to make such return shall be liable to a penalty of ten dollars, to be recovered for the use of any town or city where such neglect shall be proved to have existed.

SEC. 2. The secretary of the commonwealth shall prepare and furnish to the clerks of the several towns and cities in this commonwealth blank forms of returns as hereinbefore specified, and shall accompany the same with such instructions and explanations as may be necessary and useful; and he shall receive said returns and prepare therefrom such tabular results as will render them of practical utility, and shall make report thereof annually to the legislature, and generally shall do whatever may be required to carry into effect the objects of this act, and of the several provisions of the revised statutes not inconsistent with this act.

Approved by the governor March 3, 1842.

1844.

CHAPTER 159.—AN ACT relating to the registry and returns of births, marriages, and deaths.

Be it enacted by the senate and house of representatives in general court assembled, and by the authority of the same, as follows:

SECTION 1. The clerks of the several cities and towns in this Commonwealth shall, annually, in the month of June, transmit to the secretary of the Commonwealth a certified copy of their record of births, marriages, and deaths which have occurred within their respective cities and towns during the year next preceding the first day of said month. The births shall be numbered and recorded in the order in which they are received by the clerk. The record of births shall state in separate columns the date of the birth, the place of birth, the name of the child (if it have any), the sex of the child, name and surname of one or both of the parents, occupation of the father, residence of the parents, and the time when the record was made. The marriages shall be numbered and recorded in the order in which they are received by the clerk. The record of marriages shall state in separate columns the date of the marriage, the place of the marriage, the name, residence, and official station of the person by whom married, the names and surnames of the parties, the residence of each, the age of each, the condition of each (whether single or widowed), the occupation, names of the parents, and the time when the record was made. The deaths shall be numbered and recorded in the order in which they are received by the clerk. The record of deaths shall state in separate columns the date of the death, the name and surname of the deceased, the sex, condition (whether single or married), age, occupation, place of birth, names of the parents, disease or causes of death, and the time when the record was made.

SEC. 2. The school committee of each city or town shall, annually, in the month of May, ascertain from actual inquiry or otherwise, all the births which have happened within such city or town during the year next preceding the first day of said May, together with the facts concerning births required by the first section of this act, and shall make an accurate return thereof to the clerk of such city or town on or before the last day of said May; and the said school committee, or other person authorized by them to make such returns, shall be entitled to receive from the treasury of such city or town five cents for each and every birth so returned.

SEC. 3. Every justice, minister, and clerk, or keeper of the records of the meeting wherein any marriages among the Friends or Quakers shall be solemnized before him, together with all the facts relating to marriages required by the first section of this act, and each such justice, minister, clerk, or keeper shall, between the first and tenth days of each month, return a copy of the record for the month next preceding, to the clerk of the city or town in which the marriage was solemnized; and every person as aforesaid, who shall neglect to make the returns required by this section shall be liable to the penalty provided in the eighteenth section of the seventy-fifth chapter of the revised statutes.

SEC. 4. Each sexton or other person having the charge of any burial ground in this commonwealth shall, on or before the tenth day of each month, make returns of all the facts required by the first section of this act, connected with the death of any person whose burial he may have superintended during the month next preceding to the clerk of the city or town in which such deceased person resided at the time of his death. And such sexton, or other person, shall be entitled to receive from the treasury of the city or town to which the return is made five cents for the return of each death made agreeably to the provisions of this act.

SEC. 5. The clerk of each city or town shall be entitled to receive from the treasury of such city or town eight cents for the record of each birth and death: *Provided*, such clerk shall comply with this act in all respects.

SEC. 6. It shall be the duty of the clerks of the several cities and towns to make such distribution of blank forms of returns as shall be designated by the secretary of the commonwealth.

SEC. 7. The secretary of the Commonwealth shall prepare and furnish to the clerks of the several cities and towns in this Commonwealth blank books of suitable quality and size, to be used as books of record, according to the provisions of this act, and also blank forms of returns, as hereinbefore specified, and shall accompany the same with such instructions and explanations as may be necessary and useful; and he shall receive said returns and prepare therefrom such tabular results as will render them of practical utility, and shall make report thereof annually to the legislature, and generally shall do whatever may be required to carry into effect the provisions of this act.

SEC. 8. Any clerk who shall neglect to comply with the requirements of this act shall be liable to a penalty of ten dollars, to be recovered for the use of any city or town where such neglect shall be proved to have existed.

SEC. 9. An act entitled "An act relating to the registry of births, marriages, and

deaths," passed on the third day of March, in the year one thousand eight hundred and forty-two, is hereby repealed.

SEC. 10. This act shall take effect from and after its passage.

Approved by the governor March 16, 1844.

1849.

CHAPTER 202.—AN ACT relating to the registration of births, marriages, and deaths.

Be it enacted by the senate and house of representatives in general court assembled, and by the authority of the same, as follows:

SECTION 1. Town and city clerks are hereby authorized and required to obtain, record, and index the information concerning births, marriages, and deaths now required by law. Towns and cities containing more than ten thousand inhabitants may choose a person other than the town or city clerk to be town or city registrar to perform this duty instead of the town or city clerk; and said registrar shall take an oath faithfully to perform the duties of the office.

SEC. 2. The fees of the clerk and registrar for obtaining, recording, and indexing the information required by this act shall be as follows: For each birth, twenty cents; for each intention of marriage, including the certificate to the parties, fifty cents; for each marriage solemnized, ten cents; for each death, five cents; and the undertaker shall be allowed ten cents for information concerning each death which he returns to the clerk or registrar. Said fees for births, deaths, and marriages solemnized shall be paid by the town; and for intentions of marriage, by the parties having such intentions: *Provided, however*, That the aggregate compensation allowed to any clerk or registrar may be limited by any town or city containing over ten thousand inhabitants, but in no case so as to prevent the full execution of this act.

SEC. 3. Any undertaker or other person having the superintendence of the burial of any deceased person, who shall neglect or refuse to obtain and return the information required by this act concerning each person deceased, whose burial shall come under his superintendence, shall be liable to a penalty not exceeding twenty dollars for each neglect, and, if an undertaker, to be deprived of his office. And every clerk or registrar who willfully neglects or refuses to perform the duties herein prescribed shall be liable to a penalty of not less than twenty nor more than one hundred dollars for each neglect or refusal. All penalties and forfeitures under this act may be recovered by any person who shall sue for the same, one half thereof to the use of said complainant, and the other half to the use of the town or city in which the forfeiture shall have been incurred.

SEC. 4. The returns required to be made on the first day of February, in the year one thousand eight hundred and fifty, shall include the births, deaths, and marriages from the first day of May, in the year one thousand eight hundred and forty-eight, to said day of return.

SEC. 5. Copies of records, in the several towns and cities, of the births, marriages, and deaths which occurred during the next preceding year ending December thirty-first, shall be returned to the secretary of state annually, on or before the first day of February. The blank forms of said returns shall be printed on paper of uniform size; and those for each year, when filled out and returned to the office of the secretary of state, shall be bound together in one or more volumes, and shall be furnished with an index. Blank books for indexes to the town registrars shall be prepared by the secretary of state, and furnished to the several towns and cities at the expense of the commonwealth.

SEC. 6. All parts of acts inconsistent with the provisions of this act are hereby repealed.

Approved May 2, 1849.

1866.

CHAPTER 138.—AN ACT concerning the registry and return of marriages, births, and deaths.

SECTION 1. The clerk of each city and town (except in such cities and towns as choose a registrar under the eleventh section of the twenty-first chapter of the general statutes, in which cases the provisions of this act shall apply to the registrar), for receiving or obtaining, recording, indexing, and returning the facts relating to marriages, births, and deaths occurring therein, shall be entitled to receive therefrom the following sums, viz: For each marriage, fifteen cents; for each birth, thirty cents; for each death returned to him by the persons specified in sections two, three, and four of chapter twenty-one of the general statutes, twenty cents for each of the first twenty entries, and ten cents for each subsequent entry; for each death not so returned, but by him obtained and recorded, twenty cents.

SEC. 2. Chapter ninety-six of the acts of the year eighteen hundred and sixty five, and so much of section seven of the twenty-first chapter of the general statutes as is inconsistent herewith, are hereby repealed.

SEC. 3. This act shall take effect upon its passage.

Approved April 7, 1866.

1873.

CHAPTER 145.—AN ACT fixing the fees of clerks and registrars for the registry and return of births.

SECTION 1. The clerk or registrar of a city or town shall receive the sum of fifty cents for receiving or obtaining, recording, indexing, and returning the facts relating to each birth; but a city or town containing more than ten thousand inhabitants may limit the aggregate compensation allowed to their clerk or registrar.

SEC. 2. This act shall take effect upon its passage.

Approved April 2, 1873.

CHAPTER 202.—AN ACT relating to the fees of sextons and others.

SECTION 1. Section four of chapter twenty-one of the general statutes is amended by striking out the word "ten," after the words "fee of," and inserting instead thereof the words "twenty-five."

SEC. 2. This act shall take effect upon its passage.

Approved April 16, 1873.

CHAPTER 341.—AN ACT concerning fees of town clerks for obtaining and recording the facts relating to deaths.

Chapter one hundred and thirty-eight of the acts of the year eighteen hundred and sixty-six is amended by striking out the words "twenty cents," at the close of section one, and substituting therefor the words "thirty-five cents."

Approved June 6, 1873.

1875.

CHAPTER 21.—AN ACT to amend section five of chapter twenty-one of the general statutes, in relation to the registry and return of births, marriages, and deaths.

SECTION 1. Section five of chapter twenty-one of the general statutes is hereby amended by striking out the word "February," in the second line of said section, and inserting in place thereof the word "March."

SEC. 2. This act shall take effect upon its passage.

Approved February 19, 1875.

CHAPTER 341.—AN ACT to provide for the more accurate registration of vital statistics.

SECTION 1. No human body shall be buried, or removed from any city or town, until a proper certificate has been given by the clerk or local registrar of statistics to the undertaker or sexton, or person performing the burial, or removing the body. This certificate shall state that the facts required by chapter twenty-one of the General Statutes have been returned and recorded; and no clerk or local registrar shall give such certificate or burial permit until the certificate of the cause of death has been obtained from the physician, if any, in attendance at the last sickness of the deceased, and placed in the hands of said clerk or local registrar: *Provided*, That in those cities and towns where local boards of health have been established, the certificate of the cause of death shall be approved by such board before a permit to bury is given by the registrar or clerk.

Upon application, the chairman of the local board of health, or any physician employed by any city or town for such purpose, shall sign the certificate of the cause of death to the best of his knowledge and belief, if there has been no physician in attendance. He shall also sign such certificate, upon application, in case of death by dangerous contagious disease, or in any other event when the certificate of the attending physician cannot, for good and sufficient reasons, be early enough obtained.

In case of death by violence, the medical examiner attending shall furnish the requisite medical certificate.

Any person violating the provisions of this section shall be punished by a fine not exceeding twenty-five dollars.

SEC. 2. This act shall take effect on the first day of May, in the year eighteen hundred and seventy-eight; and all acts and parts of acts inconsistent herewith are hereby repealed.

Approved April 23, 1878.

CHAPTER 116.—AN ACT in relation to returns of marriages.

SECTION 1. Every justice of the peace, minister, and clerk (or keeper of the records) of the meeting wherein any marriages among the Friends or Quakers are solemnized, shall make a record of each marriage solemnized before him, together with all facts relating to the marriage required by law to be recorded. He shall also, between the first and tenth days of each month, return a copy of the record for the month next preceding, to the clerk or registrar of the city or town in which the marriage was solemnized, and shall, when one or both of the parties to the marriage resides in a city or town other than that in which the marriage is solemnized, return a copy of the record of such marriage to the clerk or registrar of the city or town in which either party resides, and to both cities or town when the parties reside in different places. All marriages so returned shall be recorded by the clerk or registrar.

SEC. 2. Every person neglecting to make the returns required by the preceding section shall forfeit for each neglect not less than twenty nor more than one hundred dollars.

SEC. 3. Sections sixteen and seventeen of chapter one hundred and six of the General Statutes are hereby repealed.

Approved March 13, 1879.*

CHAPTER 33.—AN ACT to compel a more accurate registration of births.

SECTION 1. It shall be the duty of every physician and midwife in the several cities and towns in this commonwealth, excepting Boston, to report on or before the fifth day of each month to the clerk of each city and town a correct list of births of all children born therein during the month next preceding, at which such physician or midwife was present, stating therein the place, date of each birth, and parents' names.

SEC. 2. Town and city clerks shall give public notice that they are prepared to furnish the necessary blanks to all physicians and midwives applying therefor.

SEC. 3. Any physician or midwife neglecting to report such list for ten days after it is due shall for each offense forfeit a sum not exceeding twenty dollars.

SEC. 4. This act shall take effect upon its passage.

Approved February 26, 1880.†

MICHIGAN.

The reports of registration of births, marriages, and deaths in Michigan have been published under the general direction of the secretary of state for ten years, the tenth annual report being for the year 1876, and issued in 1881. The compilation of these reports is made by Dr. Henry B. Baker, secretary of the State board of health, who is also superintendent of vital statistics. The returns are very incomplete, the estimated deficiency in returns of births being about 32 per cent., and of deaths about 46 per cent. The tabulations given are elaborate and accompanied with graphic diagrams. The reports are very valuable in an educational point of view.

Laws of Michigan concerning the solemnization of marriages and the record, return, and compilation of births, marriages, and deaths, with suggestions to persons authorized to solemnize marriages in Michigan, as published by the State board of health.

[Compiled Laws of 1871.]

CHAPTER CLXIX.

MARRIAGE.

CHAPTER 83 OF REVISED STATUTES OF 1846.‡

(4719.) SECTION 1. Every male who shall have attained the full age of eighteen years, and every female who shall have attained the full age of sixteen years, shall be capable in law of contracting marriage, if otherwise competent.

(4720.) SEC. 2. Marriage, so far as its validity in law is concerned, is a civil contract, to which the consent of parties capable in law of contracting is essential.

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* From Appendix 39, Registration Report, Mass., 1880, p. clxxvi.

† From Appendix 39, Registration Report, 1880, p. clxxvi.

‡ For prior statutes relative to the solemnization of marriages, see Woodward Code, p. 42; Cass Code, p. 111; Code of 1820, p. 259; Rev. of 1827, p. 280; Laws of 1832, p. 6; Rev. of 1838, p. 329; R. S. of 1838, p. 333.

(4721.) SEC. 3. No man shall marry his mother, grandmother, daughter, granddaughter, stepmother, grandfather's wife, son's wife, grandson's wife, wife's mother, wife's grandmother, wife's daughter, wife's granddaughter, nor his sister, brother's daughter, sister's daughter, father's sister, or mother's sister.

(4722.) SEC. 4. No woman shall marry her father, grandfather, son, grandson, stepfather, grandmother's husband, daughter's husband, granddaughter's husband, husband's father, husband's grandfather, husband's son, husband's grandson, nor her brother, brother's son, sister's son, father's brother, or mother's brother.

(4723.) SEC. 5. No marriage shall be contracted whilst either of the parties has a former wife or husband living, unless the marriage with such former wife or husband shall have been dissolved.

(4724.) SEC. 6. No white person shall intermarry with a negro, and no insane person or idiot shall be capable of contracting marriage.

(4725.) SEC. 7. Marriages may be solemnized by any justice of the peace in the county in which he was chosen, and they may be solemnized throughout the State by any minister of the gospel who has been ordained according to the usages of his denomination, and who is a pastor of any church or churches in this State, or who shall continue to preach the gospel in this State: *Provided*, That all non-resident ministers of the gospel who are authorized by this act to solemnize marriages shall keep proper records and make returns as required by section two, chapter sixteen, of the compiled laws of eighteen hundred and seventy-one.*b

(4726.) SEC. 8. All justices of the peace and ministers of the gospel are hereby authorized and required, before solemnizing any marriage, to examine at least one of the parties on oath, which oath they are hereby authorized to administer as to the legality of such intended marriage.

(4727.) SEC. 9. In the solemnization of marriages no particular form shall be required, except that the parties shall solemnly declare, in the presence of the magistrate or minister and the attending witnesses, that they take each other as husband and wife; and in every case there shall be at least two witnesses, besides the minister or magistrate, present at the ceremony.

Sections 10, 11, 12, 13.†

(4728.) SEC. 14. If any justice of the peace or minister of the gospel shall join any person in marriage contrary to the provisions of this chapter, he shall forfeit for every such offense a sum not exceeding five hundred dollars.

(4729.) SEC. 15. If any person shall undertake to join others in marriage, knowing that he is not lawfully authorized so to do, or knowing of any legal impediment to the proposed marriage, he shall be deemed guilty of a misdemeanor, and, upon conviction thereof, shall be punished by imprisonment in the county jail not more than one year, or by a fine not less than fifty nor more than five hundred dollars, or by both such fine and imprisonment, in the discretion of the court.

(4730.) SEC. 16. No marriage solemnized before any person professing to be a justice of the peace or a minister of the gospel shall be deemed or adjudged to be void, nor shall the validity thereof be in any way affected on account of any want of jurisdiction or authority in such supposed justice or minister: *Provided*, The marriage be consummated with a full belief on the part of the persons so married, or either of them, that they have been lawfully joined in marriage.

(4731.) SEC. 17. The preceding provisions of this chapter, so far as they relate to the manner of solemnizing marriages, shall not affect marriages among the people called Friends or Quakers; nor marriages among people of any other particular denomination having, as such, any peculiar mode of solemnizing marriages; but such marriages may be solemnized in the manner heretofore used and practiced in their respective societies or denominations.

(4732.) SEC. 18. The original certificates and records of marriage made by the minister or justice, as prescribed in this chapter, and the record thereof made by the county clerk, or a copy of such record duly certified by such clerk, shall be received in all courts and places as presumptive evidence of the fact of such marriage.

[Compiled laws of 1871.]

CHAPTER XVI.—An act to provide for the registration of births, marriages, and deaths, being act No. 194 of 1867, as amended by act No. 125 of 1869.

SECTION 1. *The people of the State of Michigan enact*, That it shall be the duty of the supervisor of each township, and the supervisor or assessor of any city or ward therein, in this State, between the tenth day of April and the first day of June, in the year eighteen hundred and sixty-nine, to ascertain, by actual inquiry or otherwise, of the

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* As amended by act No. 85, Laws of Michigan, 1873. Previous to 1871 the mayor of Flint was also authorized to solemnize marriages.

† Repealed by act 194, Laws of 1867, p. 266, sec. 10.

inhabitants thereof, the births and deaths which have occurred in their respective townships, cities, or wards, from and including April fifth, eighteen hundred and sixty-eight, to and including December thirty-first, eighteen hundred and sixty-eight, together with the facts relative thereto, as are hereinafter provided for, and shall make an accurate return thereof to the clerk of the county in which such township or city is situated, on or before the first said day of June; and for such service shall receive ten cents for each birth and death so returned by them, to be paid by the county in which such returns are made. In the year eighteen hundred and seventy, and in each and every year thereafter, it shall be the duty of the officers above mentioned, between the tenth day of April and the first day of June, to ascertain, by actual inquiry or otherwise, of the inhabitants thereof, the births and deaths which have occurred in their respective townships, cities, or wards, during the year ending on the last day of the preceding December, and shall make the return and receive therefor the compensation above provided for: *Provided*, That in the city of Detroit the duties required by this act to be performed by supervisors and assessors shall be performed by persons appointed by the common council for that purpose; and it shall be the duty of the common council, on or before the tenth day of April in each year, to appoint such number of persons in each ward of said city as shall be necessary to perform said duties within the time limited by this act; and such persons shall possess all the authority conferred upon and perform all the duties required by supervisors and assessors by this act, within the territory assigned them, respectively, by the common council, and shall receive such compensation for their services, not exceeding the sum allowed by this act to supervisors and assessors, as shall be fixed by the common council, to be paid by the county of Wayne, and shall be liable to the same penalties for refusal or neglect to perform any of said duties.

SEC. 2. Every justice of the peace, minister of the gospel, and all other persons authorized by law to solemnize marriages in this State, shall make a record of each marriage so solemnized by him, and every clerk or keeper of the records of the meetings in which any marriage among the Friends or Quakers shall be solemnized, shall make a record of such marriage, together with all the facts relating to the same, as required by the third section of this act, and such justice, minister of the gospel, clerk, or other person shall, at the time such marriage is solemnized, deliver on demand, to either of the parties so joined in marriage, as aforesaid, a certificate of such marriage, containing all the facts in relation thereto, required by said third section of this act, and shall within ninety days thereafter deliver to the clerk of the county in which such marriage took place a certified copy of such record, and, at the same time, pay to the clerk twenty-five cents for recording the same. *

SEC. 3. It shall be the duty of the county clerks of the several counties in this State, on receiving the returns of such births, marriages, and deaths, to record the same at length in separate books, to be provided at the expense of the State by the secretary of state for that purpose, with proper indexes thereto. The births, marriages, and deaths shall be numbered and recorded in the order in which they are received by the clerk, and the record of marriages shall be indexed, using both the name of the bridegroom and bride. The record of births shall state, in separate columns, the date of the birth, the name of the child (if it have any), the sex and color of the child, the place of birth, the Christian and surname of both parents, the residence and nativity of the parents, the occupation of the father, and the date when the record was made: *Provided*, That in case the child has no Christian name, such name shall be obtained and reported to the county clerk in the next annual report of the supervisor or assessor, and such Christian name shall be distinctly designated in such report as the Christian name belonging to a child previously reported, and shall be properly entered by said county clerk in the blank left for such Christian name in his book of record; and it shall be the duty of the several county clerks, on or before the tenth day of April in each year, to give to the officers required to make the said returns, lists of such children whose Christian names have not been previously reported in their respective towns, cities, or wards. The record of marriages shall state, in separate columns, the date and place of marriage, the Christian and surname of the bridegroom and bride, and the maiden name of the bride, if a widow, the color, age, and place of birth of each, the residence of each at the time of marriage, the occupation of the bridegroom, and the name and official sration of the person by or before whom they were married, the names and residences of at least two witnesses present at such marriage, and the date when such record was made. The record of death shall state, in separate columns, the date of the death, the Christian and surname of the deceased, the sex and color, whether married or single, the age in years, months, and days, the place of death, the disease or apparent cause of death, the nativity of the deceased, and the occupation, if any, and the names, residence of the parents, if known, and the date when such record was made. The clerks of the several counties

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* Blanks for return of marriages to the county clerk are prepared by the secretary of state and sent to the clerks of the several counties, from whom they may be obtained upon application.

shall annually, on or before the first day of September, make and transmit to the secretary of state a certified copy of the records of his office, of all the births, marriages, and deaths reported in their respective counties for the year ending December thirty-first, last preceding. And each county clerk shall receive for the record of each birth and death in his office three cents, and three cents for each birth, marriage, and death returned by him to the secretary of state, to be paid by the county, and shall be compensation in full for all services required by this act to be performed by him.

SEC. 4. The secretary of state shall prepare and furnish to the county clerks of the several counties in this State blank books of suitable quality and size, with proper ruilings and headings, to be used as books of record, in carrying into effect the provisions of this act. He shall also prepare and furnish blank "forms of returns," as hereinbefore specified, accompanied with such instructions and explanations as may be necessary to insure uniformity in such returns, which blanks shall be forwarded to the several county clerks on or before the first day of March in each year; and the said county clerks shall deliver the same to the supervisors or assessors of the several townships, cities, or wards therein, in their respective counties, on or before the tenth day of April.

SEC. 5. It shall be the duty of the secretary of state to receive the returns made in pursuance of the third section of this act, and he shall cause the same for each year to be bound together in one or more volumes at the expense of the State, and make indexes thereto; and with such assistance as may be voluntarily rendered by any authorized committee appointed by the medical faculty of the University of Michigan, or by any regularly authorized medical society in this State for that purpose,* he shall prepare such tabular statements, results, and deductions therefrom as will render them of practical utility, and make report thereof annually to the governor of the State, which report may be ordered published and distributed in such manner as the legislature may from time to time direct.

SEC. 6. Every justice of the peace, minister of the gospel, and all other persons authorized by the laws of this State to solemnize marriages, and clerks or keepers of records of the meetings in which any marriage among the Friends or Quakers shall be solemnized, who shall neglect or refuse to make a record of such marriage, or to deliver to the county clerk of the county in which the marriage took place a certified copy of such record, or who shall refuse, on demand, to deliver to the parties to such marriage the certificate thereof, as required by section two of this act, or who shall wilfully make a false or fictitious entry in his record of marriages, or in the certified copy of such record delivered to the county clerk, or in the certificates of marriages delivered to the parties thereto, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not exceeding one hundred dollars, and in default of paying the same shall be imprisoned in the county jail of the county in which such conviction shall be had until said fine be paid, but not to exceed the period of ninety days.

SEC. 7. Every physician, surgeon, or midwife who shall have been in attendance upon any deceased person, shall, upon application of any supervisor or assessor of the township, city, or any ward thereof, in which such death occurred, make out and deliver to such supervisor or assessor a certified statement without fee, containing the name of the disease, or cause (if known) producing the death of such person; and any medical attendant who shall neglect or refuse to give such statement, or who shall willfully make a false statement in relation to such death, shall, for such offense, be liable to pay a fine of not less than ten nor more than fifty dollars, and the costs of prosecution, which fine the supervisor or assessor is hereby required to sue for and collect in his official character.

SEC. 8. It shall be the duty of each supervisor or assessor to obtain the facts in relation to births and deaths within his township, city, or any ward therein (not otherwise obtained), from the heads of families, the keepers, overseers, or superintendents of asylums, hospitals, jails, prisons, workhouses, almshouses, houses of correction, and similar institutions, the keepers of hotels, public and private boarding-houses, and the masters or chief officers of steamboats and sail vessels navigating any of the waters of this State, and touching at any port of entry therein, in which births or deaths occurred; and if either of the above-named persons shall refuse to give such information, then the same shall be obtained by such supervisor or assessor from any person having a knowledge of the facts in relation to such birth or death; and if the supervisor or assessor shall have reason to believe that any person or persons willfully misrepresented or concealed any facts relative to such birth or death in his township, city, or any ward therein, which he cannot otherwise obtain, he may examine such person or persons on oath (which oath such supervisor or assessor is hereby empowered and authorized to administer) in relation to any birth or death within his township, city, or any ward therein, of which such person or persons may have any

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* Practically amended by section 10 of act No. 81, Laws of Michigan, 1873, printed on page 7.

knowledge or information; and if any person, after being duly subpœnaed (as provided for compelling the attendance of witnesses in justices' courts) by such supervisor or assessor, for the purposes aforesaid, shall neglect or refuse to appear before such officer, or, appearing, shall refuse to be sworn and testify in relation to such matter, he shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished therefor by fine not exceeding fifty dollars, and in default of paying the same shall be imprisoned in the county jail of the county in which such conviction shall be had, until said fine be paid, but not exceeding ninety days; and any person who, after being duly sworn as aforesaid, shall willfully make any false statement in relation to any birth or death about which he is required to testify, shall be deemed guilty of willful and corrupt perjury: *Provided*, That no person shall be required to answer any question which will tend to criminate himself or herself upon any such examination.

SEC. 9. In case of the refusal or neglect by any of the officers mentioned in this act to perform any of the duties hereinbefore required of them, or either of them, to be done and performed by any of the provisions herein contained, such officer shall be liable to a fine not to exceed one hundred dollars and the costs of prosecution, and the prosecuting attorney in each county is hereby required to prosecute, in the name of the people of the State of Michigan, all persons in his county who shall willfully violate any of the provisions of this act; and the said supervisor and assessors of any township, city, or any ward therein, may be prosecuted for a misdemeanor under this section, and upon conviction punished as therein provided for.

SEC. 10. Sections three thousand two hundred and thirteen, three thousand two hundred and fourteen, three thousand two hundred and fifteen, and three thousand two hundred and sixteen of the compiled laws of eighteen hundred and fifty-seven, be and the same are hereby repealed.

SEC. 11. The several supervisors and assessors of the townships, villages, and cities in this State, who have made any returns of births and deaths to the county clerk of their respective counties for the year eighteen hundred and sixty-eight, and have not received the amount of compensation as provided for in this act, shall be paid therefor at rates set forth in the preceding sections. And such county clerks as have made returns of births, marriages, and deaths to the secretary of state for the year eighteen hundred and sixty-eight, and who have not received compensation therefor, shall be paid for the same at the rates set forth in the preceding sections.

AN ACT to establish a State board of health, to provide for the appointment of a superintendent of vital statistics, and to assign certain duties to local boards of health, being act No. 81, laws of 1873.

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SEC. 10. The secretary of the State board of health shall be the superintendent of vital statistics. Under the general direction of the secretary of state, he shall collect these statistics and prepare and publish the report required by law relating to births, marriages, and deaths.

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Approved April 12, 1873.

SUGGESTIONS TO PERSONS AUTHORIZED TO SOLEMNIZE MARRIAGES IN MICHIGAN.

A thorough knowledge of the law concerning the solemnization and return of marriages in Michigan is necessary to a correct performance of the duties of persons authorized to solemnize marriages.

The most frequent violation of the law is in the marriage of persons under the lawful age, which is, for males 18 years, and for females 16 years. See section 4719 Compiled Laws of 1871, printed on a previous page. The penalty for the violation of this provision is a forfeit of not exceeding $500 dollars. See sec. 4728, Compiled Laws of 1871, printed on a previous page.

In recording the birth-place of each, the State or county should be distinctly given in each case. This will avoid the difficulty of ascertaining the nativity of persons whose birth-place is returned "Holland," "Hanover," "Denmark," "Wales," "Paris," &c., names of places which may be either in the United States or Europe. If such or similar names occur, please state whether it is Holland, Michigan, or Holland, Europe, and so for each case.

Never return the birth-place "America," as we cannot know whether it is in the United States, and are therefore compelled to compile it with the "Unknown." For statistical purposes it is desirable that every item be furnished which is called for by the blank upon which you make your returns to your county clerk, giving close attention to the foot-notes upon the blank.

In making your returns to the county clerk you should give your official station, as well as your name.

Blanks for the return of marriages to the county clerk can be obtained of the county clerk, who can obtain them from the secretary of state at Lansing.

MINNESOTA.

Be it enacted by the legislature of the State of Minnesota:

SECTION 1. The assistant secretary of state shall be *ex officio* commissioner of statistics. It shall be his duty annually to collect and compile from official and any other reliable sources statistics of the State of Minnesota pertaining to its agriculture, manufactures, commerce, and population, including vital statistics and all useful facts which he may be able to gather bearing upon the material and social interests of the State, and tending to afford at home and abroad a correct knowledge of its resources and progress.

SEC. 2. The said commissioner of statistics shall have power to address general or special inquiries, with printed instructions and blanks for answers, or otherwise, at his discretion, to any State, district, county, city, or town officer, and it shall be the duty of such officer to answer fully and promptly such general or special questions as may be addressed to them by said commissioner on all matters of information which can be gathered from documents or records in their official keeping, and for such services said officers shall be allowed from their respective county treasuries just and reasonable compensation, computing the same at fifteen cents for every folio furnished by them, including all preparatory labor requisite to obtain the condensed results desired, or they shall receive, if they so elect, forty cents per hour for each hour actually occupied in furnishing such information, the same to be properly verified.

SEC. 3. Each township assessor shall at the time he is required by law to make his return of taxable property to the county auditor, also deliver to him a complete statement in abstract of the number of acres cultivated and the area and product of wheat, rye, barley, buckwheat, corn, oats, beans, potatoes, sorghum, cultivated and wild hay, hops, fruit trees in bearing, berries, bees, honey, and all other products, and also the number of lumber and grist mills, and manufacturing establishments of all kinds, together with the amount of capital invested in each, the value of the annual product and the number of employees, suitable blanks for which shall be supplied by the county auditor, who shall be supplied with the same by the commissioner of statistics. For failure or neglect to perform the said duties, assessors shall forfeit any sum not exceeding fifty dollars for each offense. Each county auditor shall carefully compile and forward to the commissioner of statistics a full abstract of said returns on or before the first day of December annually, under a penalty of fifty dollars, to be forfeited to the State, for each failure or neglect to perform such duty.

SEC. 4. The clerk of each city and town in this State shall receive or obtain and register the following facts concerning the births and deaths occurring therein, separately numbering and recording the same in the order in which he receives them, designated in separate columns, viz: In the registry of births the date of the birth, the name of the child (if it have any), the sex and color of the child, the names and places of birth of the parents, and the date of the record. In the registry of deaths the date of the death, the name of the deceased, the sex, the color, the condition (whether single, widowed, or married), the age, the place of birth, the names and place of birth of the parents, the disease or cause of death, and the date of the record.

SEC. 5. Parents shall give notice to the clerk of their city or town of the births and deaths of their children; every householder shall give like notice of every birth and death happening in his house; the oldest person next of kin shall give such notice of the death of his kindred; the keeper or other proper officer of every work-house, poor-house, reform-school, jail, prison, hospital, asylum, or other public or charitable institution shall give like notice of any birth and death happening among the persons under his charge. Whoever neglects or refuses to give such notice for the period of thirty days after the occurrence of a birth or death, shall forfeit a sum not exceeding twenty dollars, to be collected as other fines are collected by law.

SEC. 6. Any physician having attended a person during his last illness shall, when requested, within fifteen days after the decease of such person, forthwith furnish for registration a certificate of the duration of the last sickness, the disease of which the person died, and the date of his decease, as nearly as he can state the same. If any physician refuses or neglects to make such certificate, he shall forfeit the sum of twenty-five dollars, to be collected as other fines are collected by law.

SEC. 7. The clerk of each city or town shall annually, on or before the tenth day of January, transmit to the clerk of the district court of the county embracing such city or town, a certified copy of the registry of births and deaths which have occurred therein during the year ending on the last day of the preceding December. He shall receive from his county treasury, for obtaining, registering, the facts herein required, twenty-five cents for each birth or death so obtained, registered, and reported, and for refusal or neglect to perform such duties as herein required he shall forfeit a sum not exceeding fifty dollars for each offense, to be collected as other fines are collected. The said clerk of the district court shall annually report to the commissioner of statistics, on or before the twentieth day of January, any abstract of the registry of births and deaths, on pain of forfeiture as hereinafter provided.

SEC. 8. It shall be the duty of the commissioner of statistics to prepare and furnish to the officers who are herein required to register and report births and deaths as aforesaid suitable blanks and instructions to facilitate the regular, prompt, and uniform performance of the duties required of them, such blanks and instructions to be forwarded to the clerks of the district courts and by them distributed to the officers aforesaid.

SEC. 9. Any person who by this act is required to give information to the commissioner of statistics, and who shall refuse or neglect to answer the inquiries addressed to him by that officer upon matters of fact or record in his official possession, shall forfeit to the State of Minnesota any sum not exceeding fifty dollars for each offense, to be collected as other fines are collected by law.

SEC. 10. The said commissioner of statistics shall, during the month of January in each year, make a written report to the governor, giving in a concise and available form the results of his labors, which shall be communicated by the governor to the legislature, and be printed, distributed, and bound with the executive documents, as provided by law.

SEC. 11. To cover all the disbursements necessary under the provisions of this act, the sum of one thousand dollars shall be annually appropriated, which sum shall include the compensation of said commissioner of statistics for the performance of the duties herein specified, and all clerk hire, stationery, and incidental expenses.

SEC. 12. All acts and parts of acts inconsistent with the provisions of this act are hereby repealed.

SEC. 13. This act shall take effect and be in force from and after its passage.

Approved March 4, 1870.

SEC. 3. *Persons prohibited from marrying.*—No marriage shall be contracted while either of the parties has a husband or wife living, nor between parties who are nearer of kin than first cousins, computing by the rules of the civil law, whether the half or the whole blood.

SEC. 4. *Marriages, by whom solemnized.*—Marriages may be solemnized by any justice of the peace in the county in which he is elected, and throughout the State by any judge of a court of record, or any ordained minister of the gospel, in regular communion with any religious society.

SEC. 5. *Ministers shall file copy of credentials with clerk of court.*—Ministers of the gospel, before they are authorized to perform the marriage rite, shall file a copy of their credentials of ordination with the clerk of the district court of some county in this State, who shall record the same and give a certificate thereof; and the place where such credentials are recorded shall be indorsed upon each certificate of marriage granted by any minister and recorded with the same.

SEC. 6. *One of parties may be examined on oath.*—All judges, justices of the peace, and ministers of the gospel may, before solemnizing any marriage, examine at least one of the parties on oath, which oath they are authorized to administer as to the legality of such intended marriage; and in no case shall such judge, justice, or minister solemnize a marriage if he is satisfied that there is any legal impediment thereto.

SEC. 7. *License to be obtained, when.*—Previous to persons being joined in marriage a license shall be obtained from the clerk of the district court of the county in which the female resides, or if not a resident of this State then from the clerk of the district court in the county where the marriage is to take place in this State; but if there shall be no such clerk in the county where such female resides, or where the marriage is to be solemnized, then no such license shall be required.

SEC. 8. *Clerk to make inquiries, and be satisfied that there is no legal impediment.*—The clerk of the district court, as aforesaid, may inquire of the party applying for marriage license, as aforesaid, upon oath or affirmation, relative to the legality of such contemplated marriage, and if the clerk shall be satisfied that there is no legal impediment thereto, then he shall grant such marriage license, and shall make a record thereof; and if any person intending to marry shall be under age, and shall not have had a former wife or husband, the consent of the parents or guardians shall be personally given before the clerk, or certified under the hand of such parent or guardian, attested by two witnesses, one of whom shall appear before said clerk and make oath or affirmation that he saw said parent or guardian subscribe, or heard him or her acknowledge the same; and said clerk is hereby authorized to administer such oath or affirmation, and thereupon issue and sign such license, and affix thereto the seal of the court. The clerk shall be entitled to receive as his fee for administering the oath and granting the license with the seal affixed thereto, recording the certificate of marriage, and filing the necessary papers, the sum of two dollars; and if any clerk shall in any other manner issue or sign any marriage license, he shall forfeit and pay a sum not exceeding one thousand dollars to, and for the use of the parties aggrieved.

SEC. 9. *No particular form of marriage required.*—In the solemnization of marriage no particular form is required, except that the parties shall declare, in the presence of the judge, minister, or magistrate, and the attending witnesses, that they take each other as husband and wife; and in every case there shall be at least two witnesses present, besides the person performing the ceremony.

SEC. 10. *Certificate to be given.*—Whenever a marriage is solemnized, the person solemnizing the same shall give to each of the parties, if requested, a certificate thereof, specifying therein the names and residence of the parties, and of at least two of the witnesses present, and the time and place of such marriage.

SEC. 11. (As amended by act of March 6, 1871.) *Record to be made and certificate delivered to clerk of court, certificate to be recorded.*—Every person solemnizing a marriage shall make a certificate under his hand containing the particulars specified in the next preceding section, and shall deliver the same to the clerk of the district court in the same county where the license was issued, and a duplicate with the clerk in the county where the marriage was solemnized, which certificate shall be filed and recorded by said clerk in a book to be kept by him for that purpose, and said clerk shall be entitled to receive the sum of twenty-five cents for recording said duplicate certificate from the person offering the same for record. S. L. 1871, 159.

SEC. 12. *Failure to deliver certificate; penalty.*—Every person solemnizing a marriage, who neglects to make and deliver to the clerk a certificate thereof within the time above specified, shall forfeit a sum not more than one hundred dollars; and every clerk who neglects to record such certificate so delivered shall forfeit the like penalty.

SEC. 13. *Penalty for solemnizing marriage contrary to law, or making false certificate.*—If any person authorized by law to join persons in marriage knowingly solemnizes any marriage contrary to the provisions of this title (chapter), or wilfully makes any false certificate of any marriage, or pretended marriage, he shall forfeit for every such offense a sum not exceeding five hundred dollars, or may be imprisoned not exceeding one year.

SEC. 14. *Penalty on persons undertaking to join others in marriage when not authorized, &c.*—If any person undertakes to join others in marriage, knowing that he is not lawfully authorized to do so, or knowing of any legal impediment to the proposed marriage, he shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by imprisonment not more than one year, or by a fine not more than five hundred dollars, or by both such fine and imprisonment, in the discretion of the court.

SEC. 15. *When marriage not void, although person officiating was not authorized.*—No marriage solemnized before any person professing to be a judge, justice of the peace, or minister of the gospel shall be deemed or adjudged to be void, nor shall the validity thereof be in any way affected on account of any want of jurisdiction or authority in such supposed judge, justice, or minister, provided the marriage is consummated with a full belief on the part of the persons so married, or either of them, that they have been lawfully joined in marriage.

SEC. 16. *Marriages among Quakers valid; duty of clerk; penalty.*—All marriages solemnized among the people called Friends, or Quakers, in the form heretofore practiced and in use in their meetings, are valid, and not affected by any of the foregoing provisions; and the clerk of the meeting in which such marriage is solemnized shall, within one month after every such marriage, deliver a certificate of the same to the clerk of the district court of the county where such marriage took place, or of the county to which such county is attached for judicial purposes, on penalty of forfeiting not more than one hundred dollars, which certificate shall be filed and recorded by such clerk under a like penalty; and if such marriage does not take place in such meeting, such certificate shall be signed by the parties and at least six witnesses present, and filed and recorded as above provided, under a like penalty.

SEC. 17. *Illegitimate children legitimatized by marriage of parents.*—Illegitimate children become legitimatized by the subsequent marriage of their parents with each other, and the issue of marriages declared null in law shall nevertheless be legitimate.

MISSOURI.

In accordance with an act approved March 20, 1866, there was appointed a commissioner of statistics for the State who made two annual reports for the years 1866 and 1867, his data being largely derived from the assessors. The records were very defective and inaccurate.

On comparing records of marriages in recorder's office with returns of the assesors of Saint Louis County, there is a difference of 1,200; of the births not more than half are recorded—in some counties scarcely at all. The records of mortality are very imperfect. In the city of Saint Louis the records of the board of health and those of the cemeteries do not agree.

In his second report he says that marriages, births, and deaths are often not recorded, and the matter of age is only a conjecture.

NEW HAMPSHIRE.

I am informed by Dr. G. P. Conn, the president of the State board of health, that very little has been done until quite recently towards enforcing the registration law, and no reports have been published by the secretary of state. The law establishing the State board of health places the supervision of registration of vital statistics with that board which begins its work in this direction this year.

Laws of the State of New Hampshire, passed June session, 1858.

CHAPTER 2072.—AN ACT providing for the registration of births, marriages, and deaths.

Be it enacted by the senate and house of representatives in general court convened:

SECTION 1. The town clerk of every town, and the city clerk of every city in this State shall annually, in the month of May, obtain and chronologically record, as required by the forms prescribed in the third section of this chapter, the facts respecting births, marriages, and deaths occurring in their respective towns and cities, and shall, on or before the second Monday of May, make duly certified returns thereof to the secretary of state, for each year ending with the last day of March, accompanying the same with a list of such persons as are required by law to make returns to him, who have neglected to do so.

SEC. 2. It shall be the duty of the secretary of state to receive the returns made in pursuance of this act, carefully file and preserve them in his office. He shall also furnish blank forms to carry out the provisions of this chapter to clergymen and others authorized to marry, to physicians, selectmen, town clerks, and clerks of the Society of Friends, substantially after the following forms, viz: The record of a birth shall state the date and place of birth, name and sex of the child, whether living or still-born; the name and surname, color, occupation, residence, and birth-place of the parents. The record of a marriage shall state the date and place of the marriage, the name, residence, and official station of the person by whom married, the names and surnames of the parties, age, color, occupation, and residence of each, condition (whether single or widowed), what marriage, if first, second, or other marriage, the occupation, birth-place, and name of their parents. The record of deaths shall state the date of death, name and surname of the deceased, the sex, color, and condition, (single or married), age, occupation, place of death, place of birth, names and birth-place of parents, and the disease or cause of death.

SEC. 3. Every person authorized by law to unite persons in marriage, shall make a record of each marriage solemnized before him, in manner and form before prescribed and annually in the month of April deliver to the clerk of the town or city in which such rite was performed, a copy of such record for the year ending on the last day of March.

SEC. 4. It shall be the duty of the selectmen and assessors of the several towns and cities of this State, annually while taking the inventory in the month of April, to ascertain by enquiry of each family or household in their respective towns and cities, and from the certificates of physicians furnished to them as is hereinafter provided, and record upon blanks supplied for that purpose, the statistics of births and deaths required in the third section of this chapter, and they shall deliver such records annually on or before the last day of April, to the clerks of their respective towns and cities. Every physician, attending in the last sickness and at the time of death of any person dying in this State, shall make a record of such death, specifying the name of the deceased, the date of death, and the disease, or cause of death, and annually, before the fifteenth day of April of each year, shall deliver a copy of such record of the selectmen of the town in which such death occurred.

SEC. 5. If any person shall wilfully neglect or refuse to perform any of the duties imposed on or required of him, by the provisions of this chapter, he shall, at the discretion of the court trying the cause, on conviction thereof, be fined not exceeding twenty dollars for each offence, one-half thereof for the use of the town in which such offence shall occur, the other half to the use of the person who shall complain of the same.

SEC. 6. The record of the town clerk of any birth, marriage, or death, or a duly certified copy thereof, shall hereafter be admitted in any court in this State as *prima facie* proof of such birth, marriage, or death.

SEC. 7. All acts and parts of acts, inconsistent with the provisions of this act, are hereby repealed.

Approved June 25, 1858.

Laws of the State of New Hampshire, passed June session, 1875.

CHAPTER III.—AN ACT in amendment of one hundred and sixty-two, section second, of the genera statutes, in relation to the record of marriages.

Be it enacted by the senate and house of representatives in general court convened:

SECTION 1. Every person before whom any marriage shall be solemnized between parties not resident in the town where the marriage is solemnized, shall forthwith make return of the record of such marriage to the clerk of the town in which the intention of marriage of the parties was entered.

SEC. 2. This act shall take effect on its passage.

Approved June 30, 1875.

Laws of the State of New Hampshire, passed June session, 1868.

CHAPTER I.—AN ACT in amendment of the general statutes.

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SEC. 49. Sections two and three of said chapter 162 of the general statutes shall be amended by inserting the words "a copy of," wherever they occur, the words "such record or," so that the original record, instead of a copy, may be returned to the clerk or selectmen.

AN ACT fixing the fees of city and town clerks for registry and return of births, marriages, and deaths.

Be it enacted by the senate and house of representatives in general court convened:

SECTION 1. That the clerk of each city and town in this State shall be paid by such city or town the following fees, to wit: For receiving, recording, and returning to the secretary of state the facts required to be recorded by section one of chapter one hundred and eighty one of the general laws, relating to each marriage, fifteen cents; to each birth and death, twenty-five cents; and for obtaining, recording, and returning the facts relating to each birth, marriage, and death, which have not been officially reported to him, fifty cents: *Provided*, that any city may limit the aggregate of such compensation.

SEC. 2. All acts and parts of acts inconsistent with this act are hereby repealed, and this act shall take effect on its passage.

Approved July 29, 1881.

The above act, and chapter 181 of the general laws, is the entire law on registration of births, marriages, and deaths, now existing in the State. The marginal references of chapter 181 simply show from what sources the chapter mentioned was compiled in the revision of the laws of the State in 1878.

NEW JERSEY.

Laws of New Jersey, 1848.

AN ACT relating to the registry and returns of births, marriages and deaths, in the State of New Jersey.

1. *Be it enacted by the senate and general assembly of the State of New Jersey,* That the clerks of the several townships in this State shall annually, in the month of June, transmit to the secretary of state in this State a certified copy of their record of births, marriages, and deaths, which have occurred within their respective townships during the year next preceding the first day of said month; the births shall be numbered and recorded in the order in which they are received by the clerk; the record of births shall state, in separate columns, the date of the birth, the place of birth, the name of the child (if it have any), the sex of the child, name and surname of one or both of the parents, occupation of the father, residence of the parents, and the time when the record was made; the marriages shall be numbered and recorded in the order in which they are received by the clerk; the record of marriages shall state, in separate columns, the date of the marriage, the place of the marriage, the name, residence, and official station of the person by whom married, the names and surnames of the parties, the

residence of each, the age of each, the condition of each (whether single or widowed), the occupation, names of the parents, and the time when the record was made; the deaths shall be numbered and recorded in the order in which they are received by the clerk; the record of deaths shall state, in separate columns, the date of death, the name and surname of the deceased, the sex, condition (whether single or married), age, oocupation, place of death, place of birth, names of the parents, disease or causes of death, and the time when the record was made.

2. *And be it enacted*, That the township clerk of each township, or some person duly authorized by him, shall annually, in the month of May, ascertain from actual inquiry, or otherwise, all the births which have happened within such township during he year next preceding the first day of said May, together with the facts concerning births required by the first section of this act, and shall make a record thereof, and file the same, with the papers of such township, on or before the last day of said May; and the said township clerk, or other person authorized by him to make such returns, shall be entitled to receive from the treasury of such township five cents for each and every birth so returned.

3. *And be it enacted*, That every justice, minister, and clerk or keeper of the records of the meeting wherein any marriages among the Friends or Quakers shall be solemnized, shall make a record of each marriage solemnized before him, together with all the facts relating to marriages required by the first section of this act; and each justice, minister, clerk, or keeper shall, between the first and tenth days of each month, return a copy of the record for the month next preceding, to the clerk of the township in which the marriage was solemnized, and every person, as aforesaid, who shall neglect to make the returns required by this section shall be liable to a penalty of ten dollars for every such neglect, to be recovered by action of debt, with costs of suit, before any court of competent jurisdiction, for the use of the township to whose clerk such returns ought to have been made.

4. *And be it enacted*, That each sexton or other person having the charge of any burial-ground or cemetery in this State shall, on or before the tenth day of each month, make returns of all the facts required by the first section of this act, connected with the death of any person whose burial he may have superintended during the month next preceding, to the clerk of the township in which such deceased person resided at the time of his death, if such death happened in the State; and such sexton or other person shall be entitled to receive from the treasury of the township to which such return is made five cents for the return of each death made, agreeably to the provisions of this act.

5. *And be it enacted*, That the clerk of each township shall be entitled to receive from the treasury of such township five cents for the record of each marriage and death; provided, such clerk shall in all respects faithfully perform his duties under this act.

6. *And be it enacted*, That the secretary of state of this State shall prepare and furnish to the clerks of the several town hips in this State blank books, of suitable quality and size, to be used as books of record, according to the provisions of this act, and also blank forms of returns, as hereinbefore specified, and shall accompany the same with such instructions and explanations as may be necessary and useful, and he shall receive said returns, and prepare therefrom such tabular results as will render them of practical utility, and shall make report thereof annually to the legislature, and generally shall do whatever may be required to carry into effect the provisions of this act, and for the faithful discharge of his duties under this act he shall be entitled to receive annually the sum of fifty dollars, to be paid by the treasurer, on a warrant produced to him signed by the governor or person administering the government of this State.

7. *And be it enacted*, That any clerk who shall neglect to comply with the requirements of this act shall be liable to a penalty of ten dollars, to be recovered by action of debt, with costs of suit, before any court of competent jurisdiction, for the use of the township where such neglect shall be proved to have existed.

8. *And be it enacted*, That the clerk of the common council or board of aldermen of any incorporated city or borough in this State, when such city or borough shall extend to and include the limits of an entire township, shall perform the same duties, receive the same compensation, and be liable to the same penalties as are by this act provided in respect to the clerks of the several townships in this State; and that in construing this act the word "clerk," meaning thereby the town clerk of any township in this State, shall be deemed and taken to include and mean the clerk of the common council or board of aldermen of any incorporated city or borough as aforesaid, and the word "township" shall be deemed and taken to include and mean any incorporated city or borough as aforesaid.

9. *And be it enacted*, That this act shall take effect from and after the first day of June next.

Approved March 3, 1848.

Laws of New Jersey, 1851.

A supplement to an act entitled "An act relating to the registry and returns of births, marriages, and deaths in the State of New Jersey," approved March third, eighteen hundred and forty-eight.

Whereas, it has been ascertained that the act to which this is a supplement has been, to a great extent, inoperative, by reason of the inadequate compensation provided in said act for performing the duties therein required: Therefore,

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That the act, to which this is a supplement, shall be so altered and amended as to increase the compensation named in the second, fourth, and fifth sections of said act, from five cents to ten cents, for performing the duties therein required.

2. *And be it enacted*, That the births shall be reported to the clerk of the township by the physician or midwife in attendance; and in case there is no physician or midwife in attendance at any birth, then the parents shall be required to report the birth to the proper officer, within one month.

3. *And be it enacted*, That should the returns from any township not be received by the secretary of state, within ten days after the expiration of the time when the same are due, it shall be his duty to notify the clerk of the township of the omission, and require the said returns to be made.

4. *And be it enacted*, That the compensation provided to be paid to the secretary of state, by the sixth section of the act to which this is a supplement, shall be increased from fifty dollars to one hundred dollars per annum.

5. *And be it enacted*, That this act shall take effect from and after the first day of June next.

Approved March 19, 1851.

Laws of New Jersey, 1862.

CHAPTER LXXXVI.—A further supplement to the act entitled "An act relating to the registering and returns of births, deaths, and marriages in the State of New Jersey," approved March third, one thousand eight hundred and forty-eight.

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That the duties required by the first and second sections of the act to which this is a supplement shall hereafter be performed by the assessors of the several townships and wards of this State; and the said assessors shall transmit to the clerks of their respective townships or cities, annually, on or before the first day of September, the record by them made as required by the said act, and which record shall include the births, deaths, and marriages by him ascertained by actual inquiry or otherwise, which have happened within such township during the year next preceding; the said assessors shall annex to said record an affidavit that he has performed the duties required by this act faithfully, to the best of his knowledge and ability; and upon receiving a certificate from the said clerk, that such return has been made to him within the time limited, together with a statement of the whole number of said births, deaths, and marriages so returned, the said assessor shall be entitled to receive from the collector of said township five cents for each birth, death, and marriage by him so as aforesaid returned, the receipt for which shall be annexed to the said certificate, and no payment shall be made unless such certificate be produced.

2. *And be it enacted*, That it shall be the duty of the clerks of the several townships and cities of this State to make a copy of said record into the township or city book for recording births, deaths, and marriages, and to transmit to the secretary of state annually, on or before the fifteenth day of September, a certified copy of said record, and upon an acknowledgment from the secretary of state of a receipt of the said copy, the said clerk shall be entitled to receive the sum of five cents for each birth, death, and marriage so returned by him; provided, that no payment shall be made for said services without a production of said receipt.

3. *And be it enacted*, That all books and blanks necessary to carry out the provisions of this act shall be sent by the secretary of state to the clerk of each county, who shall distribute them to the several township clerks for the use of the said clerks and assessors; the expenses incurred by the said county clerks shall be paid by the board of chosen freeholders of their respective counties.

4. *And be it enacted*, That the provisions of the act to which this is supplementary, and every part thereof inconsistent with the provisions of this act, are hereby repealed.

5. *And be it enacted*, That every assessor and clerk who shall fail to comply with the requirements of this act shall be liable to a penalty of twenty-five dollars, to be recovered by an action of debt in the name and for the use of the overseers of the poor of the township of which said assessor or clerk are officers, in any court of competent jurisdiction; and the said overseers are required to commence said suit upon receiving notice from the secretary of state that such record has not been received in his office within the time above limited.

6. *And be it enacted*, That this act shall have immediate effect.

Approved March 11, 1862.

Laws of New Jersey, 1863.

CHAPTER CXCVII.—A further supplement to the act entitled "An act relating to the registering and returns of births, deaths, and marriages in the State of New Jersey," approved March third, one thousand eight hundred and forty-eight.

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That the provisions of the act entitled "A further supplement to the act entitled 'An act relating to the registering and returns of births, deaths, and marriages in the State of New Jersey,'" approved March eleventh, eighteen hundred and sixty-two, shall not be held, deemed, or construed to apply to the city of Newark, in the county of Essex; and that the duties required by the first and second sections of the act to which this is a supplement shall, in and for said city, be performed by the city clerk thereof, or under his direction, according to the provisions of said act; and that in so far as the provisions of the supplement aforesaid, approved March eleventh, eighteen hundred and sixty-two, apply to the said city of Newark, the same are hereby repealed.

2. *And be it enacted*, That this act shall take effect immediately.

Approved March 19, 1863.

CHAPTER CCLVI.—A further supplement to the act entitled "An act relating to the registry and returns of births, deaths, and marriages in the State of New Jersey," approved March thirtieth, one thousand eight hundred and forty-six.

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That every justice of the peace, minister of the gospel, or the keeper of the marriage records of the Society of Friends, shall, during the month of June in each year, deliver to the assessor of the township in which such marriages are celebrated, a statement of the number of such marriages by him celebrated or recorded, containing the date and place of marriage, names and surnames of the parties, the residence, age, and condition of each (whether single or widowed), and the names of the parents of each; and for every omission or neglect to comply with the requirements herein named, such defaulter shall be liable to a penalty of twenty dollars, to be recovered in any court of competent jurisdiction, one-half thereof for the use of the overseer of the poor of the township where such defaulter shall live and the other half to the assessor of said township.

2. *And be it enacted*, That in addition to the duties prescribed in the first section of the supplement to the act named in the title to this act, passed on the eleventh day of March, one thusand eight hundred and sixxty-two, it shall be the duty of the assessors of the several townships and wards of this State, before the time limited by law for making returns to the clerk of the township, to make a personal demand on the several persons in their respective townships and wards by law authorized to solemnize or record marriages, and who have neglected to make the returns of marriages, as herein required, of the number of such marriages by them respectively solemnized or recorded during the previous year, together with the facts required by the first section of the act to which this is a supplement; and any person refusing or neglecting to give a full and correct report thereof, as by said act required, shall thereby forfeit the sum of twenty dollars, one-half to the said assessor, and one-half to the overseer of the poor of the said ward or township, to be recovered by action of debt in any court having jurisdiction thereof, in which action the said assessor shall be a competent witness.

SEC. 3. *And be it enacted*, That the affidavit required by the first section of the supplement herein above named shall have relation to, and be made in reference to, the provisions of this act.

SEC. 4. *And be it enacted*, That the assessor, in addition to his other fees, shall be entitled to receive the sum of twenty-five cents for every person on whom he shall so make demand as required by the provisions of this act.

SEC. 5. *And be it enacted*, That the secretary of state shall procure suitable books in which he shall cause to be entered an alphabetical index of all the returns made to his office, as required by the act to which this is a supplement.

SEC. 6. *And be it enacted*, That this act shall take effect on the first day of June next: *Provided*, That in the city of Newark the city clerk shall perform the duties required by this act to be performed by the assessor of townships and wards.

Approved March 25, 1863.

Laws of New Jersey, 1876.

CHAPTER CXIX.—A supplement to the act entitled "An act concerning marriages, births, and deaths," approved March twenty-seventh, eighteen hundred and seventy-four.

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That in any county of this State in which there is now established by law a county board of health and vital statistics, the returns of births, deaths, and marriages now required to be made by ministers of the gospel, physicians, and other persons shall hereafter

be made to said board of health and vital statistics only, and in no other manner whatever; and it shall be the duty of the clerk of such board to make annual returns of such births, deaths, and marriages to the secretary of state, for which the same fees shall be allowed and paid to the said clerk as are now allowed by law.

2. *And be it enacted*, That all acts or parts of acts inconsistent with the provisions of this act be, and the same are hereby, repealed, and this act shall take effect immediately.

Approved April 17, 1876.

Laws of New Jersey, 1877.

CHAPTER CX.—A supplement to an act entitled "An act concerning marriages, births, and deaths," approved March twenty-seventh, one thousand eight hundred and seventy-four.

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That the second section of "An act concerning marriages, births, and deaths," approved March twenty-seventh, in the year one thousand eight hundred and seventy-four, which reads as follows:

"Every justice of the peace and mayor of a city of this State, and every stated and ordained minister of the gospel, is hereby authorized to solemnize marriages between such persons as may lawfully enter into the matrimonial relation, and every religious society in this State may join together in marriage such persons as are of the said society, or when one of such persons is of such society, according to the rules and customs of the society to which they or either of them belong," be amended so that the said second section of said act shall read as follows:

Every judge of any court of common pleas, and justice of the peace and mayor of a city of this State, and every stated and ordained minister of the gospel, is hereby authorized to solemnize marriages between such persons as may lawfully enter into the matrimonial relation, and every religious society in this State may join together in marriage such persons as are of the said society, or when one of such persons is of such society, according to the rules and customs of the society to which they or either of them belong.

2. *And be it enacted*, That this act shall take effect immediately.

Approved March 9, 1877.

CHAPTER CXXXIV.—AN ACT to amend an act entitled "A supplement to the act entitled 'An act concerning marriages, births, and deaths,'" approved March twenty-seventh, one thousand eight hundred and seventy-four, which supplement was approved April seventeenth, one thousand eight hundred and seventy-six.

1. *And be it enacted by the senate and general assembly of the State of New Jersey*, That section one of the supplement of which this act is amendatory, which section reads as follows, to wit:

"That in any county of this State in which there is now established by law a county board of health and vital statistics, the returns of births, deaths, and marriages now required to be made by ministers of the gospel, physicians, and other persons, shall hereafter be made to said board of health and vital statistics only, and in no other manner whatever; and it shall be the duty of the clerk of such board to make annual returns of such births, deaths, and marriages to the Secretary of State, for which the same fees shall be allowed and paid to the said clerk as are now allowed by law," be, and the same is hereby, amended so as to read as follows:

That in any county of this State in which there is now established a county board of health and vital statistics, the returns of births, deaths, and marriages now required to be made by ministers of the gospel, physicians, and other persons, shall hereafter be made by such persons to said board of health and vital statistics only, and in no other manner whatever; and it shall be the duty of the clerk of such board to make annual returns of such births, deaths, and marriages to the secretary of state, for which services in making such returns there shall be allowed and paid to said clerk by the board of chosen freeholders of such county five cents for each and every name returned, upon production of a certificate from the secretary of state of the receipt by him of such returns.

2. *And be it enacted*, That this act shall take effect immediately.

Approved March 9, 1877.

Report of the board of health of New Jersey, 1879.

Vital Statistics.

UNITED ACTS CONCERNING THE REGISTRY AND RETURNS OF MARRIAGES, BIRTHS, AND DEATHS, AS NOW IN FORCE.

1. *Be it enacted by the senate and general assembly of the State of New Jersey*, That every minister of the gospel, justice of the peace, and other person having authority to solemnize marriages, and the clerk or keeper of the minutes of every religious society in this State, before which any marriage shall be solemnized, shall transmit to the proper officer, as hereinafter designated, a certificate of every particular marriage solemnized before him within thirty days thereafter, which certificate shall show the name, age, parentage, birthplace, occupation, and residence of the parties married, the time and place of the marriage, the condition of each of the parties, whether single or widowed, the name of the clergyman or magistrate officiating, and the names and residences of the witnesses; any clergyman or magistrate neglecting to send such certificate shall be liable to a penalty of ten dollars.

2. *And be it enacted*, That it shall be the duty of the physician, midwife, or other person present at the birth of every child born, and in case there be no physician or midwife present, it shall be the duty of the parent, to report in writing to the proper officer within thirty days thereafter the following particulars as far as known: The day of the month and year of the birth, the precise place of residence, the names of both parents, and the maiden name of the mother, the birthplace, residence, and occupation of the parents, the sex and color of the child, and its name, if it be named, also the name of the attending physician, under a penalty of thirty dollars: *And it is also provided*, That any assessor of a township at the time of his annual assessment, in case he finds any return of birth not made as herein provided, may fill out the certificate of the same on the usual blank signed by himself as assessor and marked "special return," and said return shall be valid as record of the birth, but shall not excuse the attendant for neglect of return.

3. *And be it enacted*, That no sexton, undertaker, or other person shall hereafter bury, within this State, or bring into or remove from this State, the body of any deceased person, without having first received a permit from the proper authority of the county, city, or township wherein such person may have died, and if so doing, said sexton, undertaker, or other person shall be liable to a penalty of fifty dollars: *Provided*, That in burying any deceased person who died in any township in this State outside of city limits or county health board limits, the certificate of any regularly graduated physician of the township wherein the person died, shall be held by the sexton or undertaker as the only necessary burial permit, to be disposed of by him as hereinafter provided.

4. *And be it enacted*, That in case of any person dying within this State, it shall be the duty of the physician who may have attended him during his last illness to furnish the undertaker, or any member of the family applying therefor, a certificate of the death of said person, which certificate shall show the name, age, sex, color, nativity, occupation, last place of residence, place of death, and cause of death, according to the best of his knowledge, and said certificate shall constitute all the necessary burial permit in any township of the State, outside of city or incorporated or county health board limits, and the undertaker shall, within five days after said burial, send the same, by mail or otherwise, to the assessor of the township in which the deceased died, under a penalty of fifty dollars, as herein provided: *And furthermore it is provided*, That any undertaker residing in an incorporated city or town may present the certificate of death, in case of any burial which he is superintending, to the city clerk or other proper officer of said city, and receive the usual permit as issued by it, on condition that said clerk shall at once transmit said certificate to the assessor of the township in which the person died, and in case there has been no physician in attendance, some member of the family, if there be any present, if not, any one present, shall notify a physician of the death at once, and the physician shall proceed to view the dead body and ascertain all the facts necessary, and, if satisfied of the cause of death, grant the township certificate for burial, and if not satisfied, shall send at once for the county coroner, or county physician, or justice of the peace, who shall take charge of the body and investigate the same, and if any person present at the death of any person shall refuse or neglect to comply with the requirements of this act, they shall be liable to a penalty of ten dollars, and the physician shall receive one dollar for viewing a dead body and granting a burial certificate, provided said physician has not been in regular attendance on the deceased, if so, no extra charge shall be made by said physician.

5. *And be it enacted*, That in any case where, on account of the absence of the proper officer, or for any other sufficient reason, it may be impossible to obtain from

said officer a permit in time for burial, it shall be lawful for any judge of the court of common pleas or any justice of the peace of the county in which the person died, on being satisfied as to the correctness of said certificate, to issue a permit for burial in the following form:

"It being impossible to obtain a burial permit from the proper officer on account of (here state the reason), I hereby grant this special permit for the burial of ———, whose death has been duly certified to me"; the said judge or justice of the peace shall at once copy upon the back of said certificate the permit as granted, and mail the same to the office of the secretary of state at Trenton, marked on the envelope, "Burial permit"; and the undertaker or other person, on the receipt of said special permit, shall pay to the said judge or justice granting the same the sum of fifteen cents.

6. *And be it enacted*, That any person who shall knowingly make any false certificate, statement, or receipt relative to any marriage, birth, or death, under the action of this law, shall be judged guilty of a misdemeanor, and on conviction shall be punished by fine or imprisonment, or both, at the discretion of the court.

7. *And be it enacted*, That the proper officer to receive the certificates of marriages, births, and deaths, and to grant permits for burial, shall, in any incorporated city or borough, be the city clerk or other officer charged with these duties, and in any county having a similar officer appointed by a county board of health now organized, be such person or persons, as said incorporated city or county board of health has authorized, or may authorize, and in townships the assessor, but in townships outside of city or corporate or county health board limits, the burial certificate given by any regularly graduated physician shall constitute the burial permit as herein provided

8. *And be it enacted*, That it shall be the duty of all assessors, clerks, and other officers to transmit, on or or before the 15th day of each calendar month, to the secretary of state, at Trenton, in an envelope or package, marked "vital statistics," all the certificates of marriages, births, and deaths, as above described, received during the preceding month, or at such other intervals or periods as may be designated by the secretary of state.

9. *And be it enacted*, That it shall be the duty of such assessors, clerks, and other officers to make and keep a complete list, as far as possible, of all coroners, physicians, midwives, undertakers, clergymen, and other persons authorized to solemnize marriages, and on or about the first day of May in each year to send to each a printed copy of the sections of this act defining their respective duties, and to furnish them, on application, with the proper blanks to make the prescribed returns.

10. *And be it enacted*, That such assessor, clerk, or other officer, upon receiving a certificate from the secretary of state as to the whole number of marriages, births, and deaths returned as aforesaid, shall be entitled to receive from the collector of the township or other proper disbursing officer 10 cents for each marriage, birth, or death so returned, the receipt for which shall be attached to the said certificate, and no payment shall be made unless such certificate be produced.

11. *And be it enacted*, That the secretary of state shall appoint, on the nomination of the State board of health, of which he is a member, a suitable person, who shall be a practicing physician of at least ten years' standing, who shall receive the returns made in pursuance of this act, examine carefully and prepare, under the direction of the State board of health, such tabular statements, results, and deductions therefrom as bear upon the population, the causes and sources of disease, and the sources of special progress and deterioration, and make an annual report thereof to the State board of health, which report shall be published as a part of the annual report of said board; it shall also be the duty of the said person to prepare and issue to assessors, clerks, and other officers the blank forms of certificates and returns required by this law, and the printed sections of the law required to be distributed to physicians, clergymen, undertakers, and other persons, and he shall accompany the same with such instructions and explanations as may be necessary and useful, and shall do whatever may be required to carry into effect the provisions of this act; the secretary of state shall, as now authorized, furnish the above and other blank forms that may be required for issue on application or otherwise, but the failure to have received such blanks, unless there has been application therefor, shall not be any excuse for the disregard of the law.

12. *And be it enacted*, That at the publication of the report of vital statistics the superintendent thereof shall have caused all returns of marriages, births, and deaths for the year to which the reports relates to be arranged and alphabetically indexed, keeping each class of marriages, births, and deaths distinct and separate, and also the index and returns for each county and for all cities of over five thousand inhabitants within said county; and the same shall be kept on file with the archives of the office of the secretary of state, and for the clerical service needed the comptroller is authorized to pay the same amount as is now provided to be paid to county clerks for the same service, payable on the order of the secretary of state; and in the case of any county now having a county board of health, or of any city of over thirty thou-

sand inhabitants, the clerk of said county or of the city board shall also keep an indexed registry, and shall receive from the proper authorities of said county or city an amount for each name so registered equal to that heretofore allowed for such index and registry.

13. *And be it enacted*, That the person appointed to take charge of the certificates of marriages, birth and deaths, and to prepare the report on vital statistics, shall be paid for his services such sum as may be fixed by the State board of health: *Provided*, That he be paid out of the moneys appropriated for the use of said board: *And provided further*, That the entire amount to be expended by said board shall not exceed two thousand dollars annually, and so much of said amount as the board of health may require shall be payable by the comptroller on account rendered and signed by the president and secretary of the board, and approved by the governor.

14. *And be it enacted*, That the State board of health shall have the same power of enquiry as to vital statistics, and as to other matters relating to public health in all cities and counties of the State having city or county boards of health, as they have in other parts of the State: *Provided*, That in no case shall the enquiries interfere with the present authority of city or county boards of health, nor shall the State board of health exercise any jurisdiction over such city or county boards.

15. *And be it enacted*, That in case any of the persons designated in this law to make or transmit returns shall fail so to do, they shall be liable at suit at common law to the amounts heretofore named, but said suit must be brought by a State, and city, or township board of health, or township committee in the State, and one-half of the amount recovered shall be paid to the usual disbursing officer of the city or township, and the rest shall belong to the board or committee bringing the action.

NEW YORK.

AN ACT providing for the registry of births, marriages, and deaths. Passed April 28th, 1847.

SECTION 1. The clerks of the several school districts of this State organized by law, and where there shall be no clerk, or he shall be incapable of acting, the trustees or one of them of such district shall annually, on or before the fifteenth day of January in each year, ascertain from the most accurate means of information in their power, and report in writing to the town clerk of the town, or one of the aldermen of the ward in which the school-house of their district shall be situated, or in the city of New York to the city inspector, under appropriate heads, and in such forms as shall be prescribed by the secretary of state, the number of births, marriages, and deaths which have occurred in their districts respectively during each year preceding the first day of January, the month and day of their occurrence, the names and residences of the persons so married or dying, and the names of the parents of such children born during the year, the sex, color, and names of the children, name and residence of the officer or clergyman performing the marriage ceremony in cases of marriage, the age of the persons who shall have married or died during the year aforesaid, and the particular disease or cause of their death. The report of all marriages and births in the city of New York shall be reported direct to the city inspector, and in case there is no physician or midwife in attendance at any birth, then the parents shall be required to report to the city inspector within one month, and all deaths in the city of New York shall be reported to the city inspector as at present, every week.

SEC. 2. It shall be the duty of the town clerk of each of the towns in this State, or of any alderman receiving the report as above specified, within fifteen days after the receipt thereof to record the same in a book to be provided by him for that purpose, and to transmit a copy thereof, or of an abstract thereof in such form as shall be prescribed by the secretary of state, to the county clerk or city inspector, whose duty it shall be, within fifteen days after the receipt thereof, to forward an abstract, duly certified by him, in such form as shall be prescribed as aforesaid, to the secretary of state, who shall file the same in his office, make a complete abstract thereof, and transmit the same to the legislature as soon as may be practicable thereafter.

SEC. 3. It shall be the duty of clergymen, magistrates, and other persons who perform the marriage ceremony, to keep a registry of the marriages celebrated by them, and to ascertain as far as practicable and to note the ages of the persons married and the time thereof, and their places of birth and their residences in such registry. It shall also be the duty of physicians and professional midwives to keep a registry of the several births in which they have assisted professionally, and the time of such birth, sex, color, and the residence of the parents; and physicians who have attended deceased persons in their last sickness, clergymen who have officiated at the funeral, and sextons who have buried deceased persons, to keep a registry of the name, age,

and residence of such deceased persons and the times of their deaths. It shall be the duty of such physicians, magistrates, clergymen, and sextons to allow the clerks of the school districts within which they respectively reside to inspect such registries from time to time, and to furnish them such other information in their power as may be necessary to enable such clerks to make the returns by this act.

SEC. 4. For the performance of the duties herein required, the officers of the several districts, towns, and counties, rendering the services herein specified, shall be entitled to such compensation for their services and expenses incurred by them as may be audited and allowed by the boards of supervisors of such counties respectively.

Laws relating to the State board of health and to the registration of births, marriages, and deaths.

CHAPTER 322.—AN ACT to establish a State board of health. Passed May 18, 1880.

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SEC. 7. It shall be the duty of the State board of health to have the general supervision of the State system of registration of births, marriages, and deaths, and also the registration of prevalent diseases. Said board shall prepare the necessary methods and forms for obtaining and preserving such records, and to insure the faithful registration of the same in the several counties, and in the central bureau of vital statistics at the capitol of the State. The said board of health shall recommend such forms and amendments of law as shall be deemed to be necessary for the thorough organization and efficiency of the registration of vital statistics throughout the State. The secretary of said board of health shall be the superintendent of registration of vital statistics of the State. As supervised by the said board, the clerical duties and safe-keeping of the bureau of vital statistics thus created shall be provided for by the comptroller of the State, who shall also provide and furnish such apartments and stationery as said board shall require in the discharge of its duties. And the State board of health shall also prepare the necessary methods and forms and prescribe the rules regulating the issue and use of transfer permits, with the proper coupons attached thereto, to be issued by local organized boards of health, for the transportation of the dead bodies of persons which are to be carried for burial beyond the limits of the counties where the death occurs; and in all cases the State board of health shall require coupons to be attached to such permits, to be detached and preserved by every common carrier, or the person in charge of any vessel, said railroad train, or vehicle to whom such dead bodies shall be delivered for transportion. Any violation of such rules and regulations shall be a misdemeanor.

CHAPTER 512.—AN ACT to amend chapter four hundred and eighty-two of the laws of eighteen hundred and seventy-five, entitled "An act to confer on boards of supervisors further powers of local legislation and administration, and to regulate the compensation of supervisors." Passed May 29, 1880.

REGISTRATION OF MARRIAGES, BIRTHS, AND DEATHS.

31. To provide for the registration in the clerk's office in each town and village in the county of every marriage, birth, and death which may occur in said town or village, such registration to be made upon the report, within three days of the event, of the attending clergyman, magistrate, or physician, such registration to be made in books of record, properly bound, lettered, paged, ruled, printed indexed, and prepared for the purpose, and furnished, whenever necessary, and upon a written demand of the said clerk, by the board of supervisors to each town or village, the expense of which books shall be a proper county charge, to be paid for as a charge in the general expenses of the county.

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32. To provide books and blank forms of permits* and of medical certificates, properly printed and ruled for use for such purposes as aforesaid, and to be furnished and paid for as is provided for the books required in the next preceding section hereto. Such books and such permits shall in each case contain the name of the person or corporation to whom such permit of removal or of burial is given. Any willful nonobservance or disobedience of any rules, ordinances, or regulations of said board of supervisors, made in accordance with the powers hereby granted, shall be deemed a misdemeanor, and be punishable as such.

33. To fix the amount and provide for the payment of the registration fees in all such cases as aforesaid, and to provide for obtaining copies of such records and for the amount and payment of fees for such copies. Such copies, duly attested by such town or village clerk, shall be admitted in all the courts of this State as prima facie evidence of the facts therein set forth.

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* The description of the forms and permits is now governed by the State board of health. See p. 14, § 7, *ante*.

THE ORGANIZATION, POWERS, AND DUTIES OF LOCAL BOARDS OF HEALTH.

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SEC. 2. The supervisor and justices of the peace and the town clerks, or a majority of them, of each town in this State, together with a citizen of such town, of full age, to be elected by them, shall be the board of health for such town for each year, and they shall appoint some competent physician, not a member of said board, to be the health officer for such town. * * * It shall also be the duty of the board of health in each town, village, and city in this State to have the supervision of the registration of deaths, diseases, and the causes of death, and by its appointed officers to examine all certificates and records of death and findings of coroner's juries, and to designate the persons who shall grant permits for the burial of the dead, and to prescribe sanitary regulations for such burials, and it shall be the duty of every such board of health to supervise and make complete the registration of births, deaths, and marriages within the limits of its jurisdiction, and in so completing the said registration the cost thereof shall be a charge upon such town, village, or city, and shall not exceed fifty cents for each completely verified and registered record of a birth, death, or marriage, but the town clerks and the registering clerks provided by law in villages and cities may still keep all records of births, deaths, and marriages as required by chapter five hundred and twelve, laws of eighteen hundred and eighty.

NORTH CAROLINA.

LAWS OF 1881.

CHAPTER LXXIII.—AN ACT to ensure the annual registration of vital statistics.

SECTION 1. It shall be the duty of each and every person annually, at the time when he or she or they shall list property for taxation, to make out and sign and deliver to the township assessor, on a blank prepared and furnished as hereafter provided, a statement as follows, to wit:

1st. Whether married, unmarried, widow, or widower.

2nd. Number of births in the family within the year immediately preceding.

3rd. Number of deaths in the family within the sam etime, and the names of the diseases causing the deaths, as far as known.

4th. Whether any cases of the following diseases have occurred in the family for the year immediately preceding: Small-pox, scarlet fever, diphtheria, yellow fever, cholera.

SEC. 2. It shall be the duty of the State board of health annually to prepare and furnish to the commissioners of each county, at least thirty days before the time appointed by law for the listing of taxes, a sufficient number of blank forms or lists, in which each tax-payer or lister shall make out the statement required by section one of this act, which said blanks shall be distributed by the commissioners aforesaid to the township assessors at least five days before the time appointed by law for the listing of taxes. The form of said blanks shall be prescribed by the secretary of the State board of health, and may be accompanied by a circular from said officer giving instructions in regard to filling out the same and information desired.

SEC. 3. The blanks so made out and delivered to the assessors, as provided for in section 1 of this act, shall be forwarded by them to the clerk of the board of commissioners in each and every county, at the same time required by law for the return of the abstract of the tax list to said clerk. And it shall be the duty of said clerk to forward at once all of said blanks so returned to him to the secretary of state, who, after noting the same for record in his office, shall forward them to the secretary of the State board of health.

SEC. 4. This act shall be in force from and after its ratification.

OHIO.

[Revised Statutes 1880.]

SECTION 2116. The board of health (of a city or village) * * * create a complete and accurate system of registration of births, marriages, deaths, and interments occurring in such corporation for the purposes of legal and genealogical investigations and to furnish facts for statistical, scientific, and particularly for sanitary in quiries. * * *

SEC. 2117. In cities of the first grade of the first class, which for this purpose alone shall be co-extensive with the county, it shall be the duty of physicians and professional midwives to keep a registry of the several births at which they have assisted professionally, which registry shall contain the time of such birth, sex and color of the child, and the names and residence of the parents; clergymen and other persons authorized to solemnize marriages shall keep a registry of all marriages solemnized by them; physicians who have attended deceased persons in their last illness, and undertakers and sextons who have buried deceased persons shall keep a registry of the name and age of such persons, and their residence at the time of death; and all such physicians, professional midwives, clergymen, and all persons authorized to solemnize marriages, undertakers, and sextons shall report to the board of health all births, marriages, and deaths occurring within the limits of such city as registered by them, which reports shall be made as often as the board of health may require.

6391. A certificate of every marriage hereafter solemnized, signed by the justice or minister solemnizing the same, shall be transmitted to the probate judge in the county wherein the marriage license was issued, within 3 months thereafter, and recorded by such probate judge; every justice or minister failing to transmit such certificate to the probate judge in due time shall forfeit and pay fifty dollars; and if the probate judge shall neglect to make such record he shall forfeit and pay fifty dollars to and for the use of the county.

STATISTICS OF BIRTHS AND DEATHS.

6395. The probate judge shall keep a record of the births and deaths reported to him as hereinafter provided; the births shall be numbered, recorded, and alphabetically indexed in the order in which they are received, and the record shall state, in separate columns, the date of making the record, the date and place of birth, the name, sex, and color of the child, the maiden name of the mother and the name of the father of the child, and the residence of the parents, as fully as the same are reported; the deaths should be likewise numbered, recorded, and indexed, and the record thereof shall state in separate columns, so far as the same is reported, the date and place of death, name and surname of the deceased, condition (whether single, married, or widowed), age, place of birth, occupation, names of parents (when an infant without name), cause of death, color, and last place of residence of such deceased person, and the date of making the record.

6396. It shall be the duty of the assessors of the several townships and wards of each county of this State to obtain annually the foregoing statistics, at the time each assessor shall make the assessment of his respective township or ward for the year ending the last of March preceding each annual assessment, and report the same to the probate judge of his county at the time of his regular report to the [county] auditor; and at the time of submitting his report to the probate judge he shall state upon oath that he has made diligent inquiry in order to obtain the number of births and deaths, and other information required by this chapter, in his township or ward, respectively; and if any assessor in this State shall fail or refuse to make such report, or to make and file the affidavit required by this title, the auditor of his county shall withhold his order until the law has been complied with to the satisfaction of the probate judge, except in counties containing cities of the first class, having a population of one hundred and fifty thousand and over, in which counties it shall be the duty of the physicians and professional midwives to keep a registry of the several births in which they have assisted professionally, which shall contain, as near as the same can be ascertained, the time of such birth, sex, color of the child, the names and residence of the parents; and physicians who have attended deceased persons in their last illness, clergymen who have officiated at the funeral, and sextons who have buried deceased persons shall keep a registry of the name, age, and residence of such deceased persons at the time of their death. It shall be the duty of the physicians and professional midwives to report fully the births registered by them, as required by this chapter, to the judge of the probate court of the county every three months, viz, on or before the second Monday of the months of January, April, July, and October of each year; in case there is no physician or midwife in attendance at any birth, then the parents shall be required to report to the probate judge within one month; and physicians, clergymen, and sextons shall likewise report fully the deaths registered by them, as required by this chapter, to the judge of the probate court of the county, every three months, as above designated; and any person who shall neglect or refuse to comply with or violate the provisions of this chapter shall forfeit and pay for each offense the sum of ten dollars, to be sued for and recovered in the name of the State of Ohio, and the penalty, when recovered, shall be paid over, one-half to the school fund and one-half to the party making complaint thereof.

6397. It shall be the duty of the probate judge to furnish to each assessor of the several townships or wards of his county, annually, and to other persons making such

report, a sufficient number of properly ruled blanks, which shall be paid for out of the county treasury, upon which to make such report to said probate judge.

6398. It shall be the duty of the probate judge receiving the reports as above specified, within 15 days after the receipt thereof, to record the same in a book to be provided by the commissioners for that purpose, and to transmit an abstract thereof, on or before the first Monday of August, every year, to the secretary of state, in such form as shall be prescribed by that officer, who shall file the same in his office, to be used by him in his annual report to the legislature.

6399. Every original entry, made as above prescribed, and a copy of such entry, duly certified over the seal of said court, shall be received in all courts and places as prima facie evidence of the facts therein stated, and said records shall be open to the inspection of the public at all proper hours.

OREGON.

General laws of Oregon, 1843–'72.

MARRIAGES.

CHAPTER XXXIV, p. 661. Miscellaneous laws. [Act October 15, 1862.]

* * * * * * *

SEC. 4. Marriages may be solemnized by any minister or priest of any church or congregation in the State, anywhere within the State, and by any judicial officer of the State anywhere within his jurisdiction.

SEC. 5. In the solemnization of marriage no particular form is required, except that the parties thereto shall assent or declare in the presence of the minister, priest, or judicial officer solemnizing the same, and in the presence of at least two attending witnesses, that they take each other to be husband and wife.

SEC. 6. The person solemnizing the marriage shall give to each of the parties thereto, if required, a certificate thereof, specifying therein the names and residence of the parties, and of at least two witnesses present, the time and place of such marriage, and the date of the license therefor, and by whom issued.

SEC. 7. A person solemnizing a marriage shall, within one month thereafter, make and deliver to the county clerk of the county where the marriage took place a certificate containing the particulars specified in the last section; such certificate may be in the following form:

STATE OF OREGON,
County of ———, *ss:*

This is to certify that the undersigned (minister, priest, or judicial officer, as the case may be), by authority of a license bearing date the —— of ———, 18—, and issued by the county clerk of the county of ———, did on the —— day of ———, 18—, at the home of ——— ———, in the county and State aforesaid, join in lawful wedlock A. B., of the county of ———, and State of ———, and C. D., of the county of ———, and State of ———, with their mutual assent, in the presence of E, F., and G. H., witnesses.

Witness my hand [J. P., judge, justice of the peace, minister or priest, as the case may be.]

SEC. 8. The county clerk shall file such certifieate, and record the same in the record of marriages, and the legal fees therefor shall be paid by the person solemnizing the marriage, who shall be entitled to demand and receive the same from the parties before the marriage.

SEC. 9. Any person solemnizing a marriage who shall wilfully refuse or neglect to make and deliver to the county clerk for record the certificate mentioned in the last section, within the time in such section specified, shall forfeit for such refusal or neglect a penalty of not less than ten nor more than fifty dollars, to be recovered by action for every five days of such neglect or refusal.

PENNSYLVANIA.

The Pennsylvania act became a law without the signature of the governor. An effort was made at the succeeding session of the legislature to repeal it, and it was a dead letter in 1853.

AN ACT to provide for the registration of marriages, births, and deaths.

Whereas, from the death of witnesses, and from other causes, it has often been found difficult to prove the marriage, birth, or death of persons, whereby the rights of many have been sacrificed and great wrongs have been done;

And whereas important truths, deeply affecting the physical welfare of mankind, are to be drawn from the number of marriages, births, or deaths that during a term of years may be contracted or may occur within the limits of an extensive commonwealth; and therefore,

SECTION 1. *Be it enacted by the senate and house of representatives of the commonwealth of Pennsylvania in general assembly met, and it is hereby enacted by the authority of the same,* That from and after the first day of July next each register of wills in the several counties of the State shall be supplied with separate books, in which he shall register, in the manner hereinafter directed, the marriages which may have been contracted, and the births and deaths, which may have occurred, within his county.

SEC. 2. That it shall be the duty of every clergyman, alderman, justice of the peace, clerk or keeper of the records of the religious society of Friends, and of every other person or society by or before whom any marriage may hereafter be solemnized or contracted, to make at once a record of the same in a book to be kept for the purpose, and within the space of thirty days after such marriage to return the same in the form of a certificate, duly signed by the person so certifying, to which the register of the county in which such marriage shall have been solemnized or contracted, which said record or certificate shall set forth, as far as the same can be ascertained, the full name of the husband, his occupation, and the name of his place of birth and residence; the full name of the wife previously to the said marriage; the names of the parents of said husband, and the parents of said wife; also the color of the parties, and the time and place and ceremony; where and by whom such marriage was contracted; and if pronounced by any clergyman, or other person as aforesaid, the place of residence of such person.

SEC. 3. That it shall be the duty of every physician, under whose care a birth shall hereafter take place, to make at once a record of such birth in a book to be kept for that purpose, and to return the same, duly signed by him or her, in the form of a certificate, to the register of the county in which such birth shall have taken place, in the manner and within the period directed by the second section of this act, which said record and certificate shall set forth, as far as the same can be ascertained, the full name of such child, if any name shall have been conferred, its sex, color, the full name as well as occupation of its parent or parents, names of any other child or children living, and, for better identification, the full name previously to marriage of the mother of such child, and the day and hour and place on and at which such birth occurred, and any circumstances connected with such birth that may be deemed of interest in case such birth shall have occurred without the superintendence of any person, and should no physician or other person be in attendance upon the parent immediately thereafter, it shall then become the duty of the parent or parents of such child to return the same to the register in the manner, form, and within the period above required.

SEC. 4. That every physician or surgeon who shall hereafter be in attendance at the period of the death of any individual, dying within this State, shall make at once a record of such death in a book to be kept by him for that purpose, and shall return the same, duly signed, in the form of a certificate, to the register of the county in which such individual may have resided at the time of death, in the manner and within the period directed in the second section of this act; which record and certificate shall set forth, as far as the same can be ascertained, the full name, sex, and color of the person deceased, and his or her age; also the name of his or her parents; the occupation, place of birth, and the period, place, and disease or cause of death, and, if within his knowledge, the name of the burial ground in which interred; and if married at the time of death the name of the husband or wife, as the case may be; and no person having the charge as sexton of any vault or burial ground within the city or county of Philadelphia shall inter or permit, or caused to be interred, the dead body of any person in such vault or burial ground without first procuring a copy of such record, duly certified as aforesaid by the person who made it, and which certificate as aforesaid, when obtained, he shall sign, and before the expiration of

thirty days from the time at which he may have received it, shall return the same to the register aforesaid; and every physician, coroner, or other person who shall neglect or refuse to furnish such sexton or other person, previous to such interment, within the said city or county, the certificate required by this section, and every sexton, or other person, having the care or superintendence of any vault or burial ground, who shall neglect to procure such certificate as aforesaid, or having procured it shall neglect or refuse to return it as aforesaid, shall each, for every such neglect or refusal, forfeit and pay the sum of $5, which sum shall be recoverable as debts of the like are recoverable by any person who may sue for the same; all certificates or returns required by this act shall be signed by the parties so certifying.

SEC. 5. That this act shall not be construed to prevent the registry of any marriage contract, or birth or death happening, previously to its passage, within the limits of this State, nor of any marriage, birth, or death of any person or persons, who may have married, been born, or may have died elsewhere, but who were the child or children of citizens of this State, nor of any marriage contracted previously or subsequently to the passage of this act in any other part of these United States, or their Territories, or beyond the limits of the same: *Provided*, Either of the parties married were permanently residing in this State at the time, or at some time previously or subsequently to such marriage, and such registration shall be in the form already prescribed, and shall be kept apart from the current registration, and in separate books, as already required in the case of other registrations, but shall be embraced in the general index; the proof of every such marriage shall be as follows, to wit: In the case of a marriage by the person who pronounced it, or if such proof cannot be made, or the marriage shall have been contracted according to the manner of the religious society of Friends, then it shall be made by some one who was present thereat; in the case of a birth, by some one who has actually knowledge of the period at which such person was born, or of his or her parentage, and in the case of a death by some one who actually saw such person dead, or who has actual knowledge of the fact, such proof shall be under oath or affirmation, and shall be in its character satisfactory to the register: *Provided, further*, That should any person feel aggrieved at the decision of the register aforesaid, he or she, or, as the case may be, the next friend or representative of the person on whose behalf such application is made, shall have the right of an appeal to the orphans' court of the proper county, in which case the testimony so taken shall be sent up with the appeal to the said court by the said register, accompanied by a written statement of his reasons for rejecting it as insufficient.

SEC. 6. That no letters of administration or letters testamentary shall be granted by any register upon the estate or effects of any person hereafter dying within this State, or, if granted, shall be valid, until the death of such person shall be duly certified to the register, in order that the same may be duly registered, according to the forms and provisions of this act, or as strictly in compliance therewith, as it may be in the power of the party so to do.

SEC. 7. That no appointment of any guardian to the person or estate, or of any minor hereafter born, by any orphans' court, within this State, shall be valid until the date of the birth of such minor, and the date of the birth, as well as the name of his or her parent or parents, shall be duly registered according to the provisions of this act, as strictly as the same can be complied with, unless from the death of any witness, or from some other cause deemed sufficient upon strict investigation by the said court, such proof cannot at the time be conveniently made, in which latter case it shall be as soon as it may be practicable.

SEC. 8. That the said books or registers, or a certificate duly certified by the register, and authenticated by his seal of office, as containing full copy of the record of any marriage, birth, or death, shall hereafter be admitted in any court of this State as prima facie proof of any marriage, birth, or death: *Provided, however*, that should no such registration exist, the proof of any marriage, birth, or death shall be sufficient if made in the manner now or hereafter required under the decisions of the supreme court of this commonwealth.

SEC. 9. That if any register shall not, within fourteen days after an application made to him to register any marriage, birth, or death, as aforesaid, register in the proper form and book any such marriage, birth, or death, as the same shall be certified to him, unless he has sufficient cause, he shall forfeit and pay the sum of ten dollars, to be recovered as debts of the same amount are recoverable by any person who may sue for the same; the person aggrieved shall have the right to appeal provided by the sixth section of this act, and all certificates of marriages, births, or deaths, duly returned, shall be preserved and filed by the register.

SEC. 10. That if any person shall wilfully, knowingly, and falsely swear or affirm to, or return any such certificate of marriage, birth, or death, or if any register shall wilfully and knowingly make, or cause to be made in the said books, a false entry of such marriage, birth, or death, the person or register so offending shall be punished by a fine or imprisonment, or both, at the discretion of the court having cognizance

of such offenses, the fine not to exceed eight hundred dollars, and the imprisonment not to exceed seven years.

SEC. 11. That the registry of marriages, births, and deaths shall be kept in separate books; there shall be general indexes to the records of all marriages, births, and deaths, which indexes of marriages, births, and deaths, respectively, shall be kept in separate books; opposite to each name in the said index shall be affixed not only the reference to the record, but the day of the month and year in which any marriage may have been contracted, or birth or death may have occurred, as the case may be.

SEC. 12. That in order to secure uniformity, precision, and greater dispatch in the aforesaid registration, the said books shall contain (upon each page of the same, and along the margin at the side of said page) printed titles, duly numbered, opposite to which shall be left blanks or spaces, in which entries shall be made corresponding to the particular subject of each of the said titles; the said titles in the books for registering marriages shall be printed and arranged in the following words and order, to wit:

1. Full name of the husband.
2. Name of the father of said husband.
3. Name of the mother of said husband.
4. Occupation of said husband.
5. Residence of husband.
6. Birth-place of husband.
7. Full name of the wife previously to marriage.
8. The name of the father of said wife.
9. The name of the mother of said wife.
10. The time when the marriage was contracted.
11. The place, town, or township and county where the marriage was contracted.
12. The color.
13. By what ceremony contracted.
14. Name of person pronouncing marriage.
15. Residence of person last named.
16. Name of person signing certificate.
17. Date of certificate.
18. Date of registration.
19. Signature of the register or his deputy.

The titles in the books for registering births, in the following words and order, to wit:

1. Full name of child.
2. Sex.
3. Color.
4. Full name of father.
5. Occupation of father.
6. Names of other issue living.
7. Name of the mother previously to marriage.
8. Hour, day of week, of month, and the year of birth.
9. Place, name of town or township, and county in which born.
10. Name of physician or other person signing the certificate, or on whose application the registry is made.
11. Residence of such person.
12. Date of certificate.
13. Date of registration.
14. Signature of the register or his deputy.
15. Any additional circumstances.

Titles in the books for registering deaths, in the following words and order, to wit:

1. Full name of the deceased.
2. Color.
3. Sex.
4. Age.
5. Name of the father of the deceased.
6. Name of the mother of the deceased.
7. Occupation.
8. Place of birth.
9. Name of wife of the deceased.
10. Name of husband of deceased.
11. Name of issue living.
12. Date of birth and date of death.
13. Cause of death.
14. Name of the place, town or township, and county in which the person died.
15. Name and location of burial ground in which interred.
16. Name of person returning certificate.

17. Residence of such person.
18. Date of certificate.
19. Date of registration.
20. Signature of register or deputy.

At the bottom of each page in each of said books there shall be left a blank for the registry of any fact which any act or acts of assembly hereafter enacted may require shall be registered, and all interlineations or erasures shall at the time be noted by the register.

SEC. 13. That the said register, with the exceptions hereinafter named, shall receive, provided he complied with the provisions of this act, for registering any marriage, birth, or death, the sum of ten cents, which shall be paid to him, on his demand, by the treasurer of the proper county, except for registering any marriage contracted or any birth or death happening previously to the year eighteen hundred and fifty-one, in which case he shall receive twenty-five cents, to be paid by the party; for examining every witness, in which the testimony is reduced to writing and length, twenty-five cents; for sending up the record or an appeal, fifty cents; for granting a certified copy of the full record of any marriage, birth, or death, fifty cents, which shall also be paid by the party, and he shall make no charge for administering an oath or affirmation, or demand a fee from any person so registering. The register for the city and county of Philadelphia shall receive six cents for making any registry as aforesaid, which shall be paid by the county treasury as aforesaid. All emoluments arising from the registration, except the amount paid by the several counties, which shall exceed the sum of one thousand dollars, shall be paid into the State treasury. In order the more effectually to guard against injury from the loss from fire or otherwise of the records of any county, and for other purposes, it shall be the duty of each register, under a penalty of twenty dollars for every neglect, recoverable as aforesaid, in each of the counties, semi-annually, between the fifteenth and twentieth days of January and July in each year, to transmit a copy of the record of marriages, births, and deaths, before specified, with a copy of the index, duly certified by him, to the secretary of the commonwealth, who shall file the same in his office, and annually transmit to the legislature an abstract of the number of marriages, births, and deaths which have occurred in each county in the State during each year next preceding the first day of January, and for the purpose the said secretary shall furnish, at the cost of the commonwealth, each of the said registers with proper blanks prepared in the form required by the thirteenth section of this act, and shall also furnish to each of the said registers, at the cost of the commonwealth, the blank books and indexes required by the first or other sections of this act, and also, at the same time, transmit a printed copy of this act, which shall be bound with said blank book, and such instructions on the subject of the law as he may see fit to prepare, and generally to do whatever may be required to carry into effect the provisions of this act.

SEC. 14. That every clergyman, justice of the peace, physician, sexton, or undertaker, whose duty it is to make any return under this act, shall, on or before the first day of October next, return his name and residence to the register of the county in which he may reside, who shall record the said return in a book to be kept for the purpose, to be provided at the expense of the county; and such person shall notify the register of his removal to any other place in or out of said county, within thirty days after such removal, except where he may cease to act in a professional or official capacity.

SEC. 15. That all the acts or parts of acts inconsistent herewith, or supplied as aforesaid, are hereby repealed.

JOHN CESSNA,
Speaker House of Representatives.
BENJAMIN MATTHIAS,
Speaker of the Senate.

We do hereby certify that the bill entitled "An act to provide for the registration of marriages, births, and deaths" was presented to the governor on the fourteenth day of April, 1851, being within ten days of the close of the last session of the legislature, and not having been "sent back within three days" of the meeting of the present general assembly, wherefore it is agreeable to the constitution of this commonweath, became a law in like manner as if he had signed it.

WILLIAM JACK,
Clerk of the House of Representatives.
JOHN M. SULLIVAN,
Clerk of the Senate.

HARRISBURG, *January* 12, 1852.

Laws of Pennsylvania, 1876 (p. 113)

No. 85.—AN ACT relating to registration of births and marriages of boards of health wherever es tablished bv law in the cities of this commonwealth.

BOARDS OF HEALTH TO FURNISH BOOKS FOR REGISTRATION.

SECTION 1. *Be it enacted, &c.*, That wherever boards of health are established by law in the cities of the commonwealth, said boards shall furnish separate books in which shall be registered, in the manner herein after directed, the returns made to said boards of the marriages which may be contracted and the births and deaths that may occur in said cities.

DUTIES OF CLERGYMEN, MAGISTRATES, PHYSICIANS, ETC.

SEC. 2. It shall be the duty of clergymen of all denominations, of clerks or keepers of records of all churches and religious societies, as also of every magistrate, and of other persons by or before whom any marriage may hereafter be solemnized or contracted, and of every practicing physician and every practioner of midwifery in said cities, on or before the first day of July next ensuing (the day in which the law goes into effect), to report his, her, or their names and places of residence to the secretary of the board of health, at the office of the board of health; and it shall be the duty of the secretary of the board of health to have the same properly registered in index form, in suitable books to be furnished by the board of health; in the event of any of the persons above specified removing to any other place of residence, it shall be their duty to notify the secretary of the board of health of the fact within thirty days after such removal, except when the persons removing shall cease to act in such official capacity as makes them subject to the provisions of this act.

DUTIES OF PERSONS PRACTICING MIDWIFERY—SCHEDULE OF BIRTHS TO BE RETURNED.

SEC. 3. Every person practicing midwifery in said cities, under whose charge or superintendence a birth shall hereafter take place, shall keep a true and exact register of such birth, and shall enter the same on a blank schedule to be furnished by the board of health; this schedule shall contain a list of the births which have occurred under his or her care during the preceding three months, and shall set forth, as far as the same can be ascertained, the full name of each child (if any name shall have been conferred), its sex, color, the full name and occupationof its parent or parents, the day and place of its birth; and the schedule shall be delivered, duly signed by the practioner in the form of a certificate, on the first days of October, January, April, and July or within ten days thereafter, to the secretary of the board of health, or to any other authorized person. In case the birth of any child shall have occurred without the attendance of a physician or practitioner of midwifery, or should no other person be in attendance upon the mother immediately thereafter, it shall then become the duty of the parent or parents of such child to report its birth to the secretary of the board of health, in the same manner and form and within the period above required.

DUTIES OF PERSONS CELEBRATING MARRIAGES.

SEC. 4. It shall be the duty of every clergyman and every magistrate, and of the clerk or keeper of the records of all religious and other societies, and of every other person by or before whom any marriage may hereafter be solemnized or contracted, to make a faithful return of the same at the expiration of every three months to the secretary of the board of health, in the form of a certificate, which shall set forth as far as the same can be ascertained, the full name of the husband, his occupation, the place of his birth, his residence and age, the date of marriage, the full name of the wife previous to the said marriage, and her age, the color of the parties, and the place where and the name of the clergyman or other person by whom the marriage ceremony was performed.

PENALTIES FOR NEGLECT.

SEC. 5. In case any clergyman, magistrate, physician, midwife, clerk, or any other person as aforesaid, shall violate any of the provisions of this act, or refuse or neglect to perform any of the duties required by the same, he, she, or they, shall forfeit and pay for every such offense the sum of not less than five or more than twenty dollars, for the use of the board of health, which sum or sums shall be recoverable as debts of like amount are now by law recoverable, and on non-payment of the same a capias ad satisfaciendum may issue.

REGISTERS AND CERTIFICATES TO BE EVIDENCE.

SEC. 6. The books or registers kept by the secretary of the board of health, or a certificate duly certified by him, as containing a copy of the record of any marriage or birth, shall hereafter be admitted in any court of the State as prima facie evidence of said marriage, birth, or death.

FEES.

SEC. 7. The secretary of the board of health shall receive, and pay into the city treasurer, fifty cents for granting a certificate or certified copy of the record of any marriage or birth, and ten cents for making a search for either a marriage or birth, which sum shall be paid by the parties applying for the certificate or search, but the said register shall at all times be accessible to physicians, clergymen, and lawyers without charge.

HOW REGISTERS TO BE PREPARED.

SEC. 8. In order to secure uniformity and dispatch in the registration herein provided for, the books shall contain upon the margin of each page printed titles with corresponding blanks for suitable entries for marriages and births, in the order, to wit:

MARRIAGES.—Full name of husband, occupation, residence, birth-place, age, when married, full name of wife previous to marriage, residence, birth-place, age, when married, time of marriage, color of parties, ceremony employed, name of person performing the marriage, residence of the last-named person, date of certificate, date of registration.

BIRTHS.—Full name of the child, sex, color, full name of the father, his occupation, full name of the mother, day, month, and year of the birth, street and number of house where born, name of physician or other person signing certificate, his residence, date of certificate, date of registration.

POWER TO MAKE RULES.

SEC. 9. The said boards of health shall have power to make all rules and regulations for carrying the provisions of this act into effect: *Provided, however,* That the provisions of this act shall not apply to cities of the first and second class.

Approved the 5th day of May, A. D. 1876.*

(Signed) J. F. HARTRANFT.

RHODE ISLAND.

In the first registration report, dated Providence, 1854, page 41 *et seq.*, is the history of registrative legislation in the colony and State from its first settlement to that date, prepared by Dr. Mauran. From this it would appear that so early as 1647 it was provided, that no contract between a man and woman to own each other as man or wife should be considered as a lawful marriage, nor their children to be legitimate, but such as are duly recorded in the town clerk's book.

In 1698, at the general assembly held at Newport, the following act was passed:

Whereas this Assembly haveing had some Information y^{t} y^{e} ways of Marriages w^{ch} by Law hath been solemnized throughout this Colony according to y^{e} Laws & Ordinances made and Enacted for y^{t} End but some neglect have been in not so duly by some People in most Towns in this Colony observed in not makeing Record of their Marriages and Births of there Children and not Entering on Record According to y^{e} Laws so Enacted & make y^{e} Register of y^{e} p^{r}sons Deceased whereby some p^{r}sons have taken y^{e} advantage of y^{e} Law to Render such p^{r}sons in s^{d} Colony not duly observeing y^{e} Act of Registering their Marriages &c. as to declare all such Children not born und^{r} y^{e} Register above mentioned to be Illegetimate w^{ch} Looks not well in any P^{r}son or p^{r}sons so Casting any Reproach on any, & for a more ord$_{r}$ly Registering the Marriages Births & Burialls according to y^{e} Laws of this Colony Bee it Enacted by this Assembly & y^{e} authority thereof, & it is hereby Enacted y^{t} all Marriages y^{t} have been solemnized throughout this Colony According to y^{e} Laws of y^{e} Colony shall & are hereby Declared to be Lawfull & good in y^{e} Law to Issue and Children born to Inherit & Possess any Lands &c. although there hath not been y^{t} due care in Registering y^{e} marriages & births &c. according to any former Act made or Enacted in any wise to y^{e} contrary notwthstanding.

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* Laws of Pennsylvania, 1876, p. 113.

Nevertheless its ye Intent of this Act yt all prsons for ye future shall duly & truly observe ye Acts & Laws of this Colony to Proceed in Marriages in all ye Towns in this Colony & by carrying into ye Town clerke of each Town there Marriages and Births of their Children and Buriall of there Dead wthin ten days after all such things are past & every Town Clerke shall make a true & due Record thereof & Bee it Further Enacted yt ye Town Clerke of every Town shall return unto ye head Majestrate of every Town or Cheif Justice of ye Peace once in a year ye accot of all such Marriages births and burialls when required yt a due corse in Law may be observed & ye table of fees shall be as followeth. To ye Majestrate yt Joynes or Pronounceth ye Lawfullness of ye Marriage & for a Certificate to ye Person Married £00:03:00.

THE TOWN CLERK'S FEES.

To ye Registering ye Marriage £00:00:06
To Registering of Birth Each £00:00:04
To Registering of Burialls Each £00:00:04

The next legislation on the subject worthy of note is the law passed by the general assembly in October, 1701, in which, among other things, it is provided that all births and burials of all children shall be registered in the town clerk's office in the same town where they happen to be born or die, by the parents of such children as shall be born or die as aforesaid, within two months' time after the birth or burial thereof. For the registering of each the town clerk shall be paid two pence by the parents of such child or children, and whosoever shall neglect so to do shall, for every month's neglect after such two months has expired, forfeit two pence per month.

From this it would seem there was no provision for registering deaths of adults.

In 1708 we find the following act:

"Whereas there is an act of this colony that all marriages, births, and burials shall be registered in the several town clerks' office in each respective town in this colony, but there being no penalty imposed in said act upon such persons as shall neglect or refuse to comply according to said act, it has, for the most part, or by the greatest part, been neglected and not complied with—

"*Be it therefore further enacted*," *&c.*, "That if any person or persons in this colony shall, or do, neglect or refuse, after the dissolution of this assembly, to give or send an account of their marriages, births, and burials to the town clerk within the space prefixed in said act, with the fees due for registering the same, shall be under the penalty of the forfeiture of three shillings, for the use of the poor of the town where the neglect shall be, to be taken by a warrant from a justice or conservator of said town.

"*And it is further enacted*, That if any town clerk, upon the return of any such marriages, births, or burials, with the fee due for registering the same, shall neglect or refuse to make record thereof in the town book, which shall be appointed for that use, he shall, for every such neglect, forfeit the sum aforesaid, to be taken and put to the use aforementioned"

This was followed in 1727 by an act reciting that the previous act had proved ineffectual, because the town treasurer, who is not the recorder of marriages, births, and burials, is empowered to sue for the same, therefore the town clerk should be the person to sue in all cases of neglect of registration, and should have one-half the penalties.

In the digest of acts and laws for 1766 is an act, pages 175–'6, entitled "An act for registering marriages, births, and burials," which simply confirms the previous legislation, but makes the penalty sixpence per month for neglect. This was subsequently changed in the digest of 1798 to eight cents penalty instead of sixpence. In the digest of 1822 the registration act is a transcript of that of 1798. In 1844 the registry act contains some additions and modifications.

It is enacted by the general assembly as follows:

SECTION 1. Every person authorized by law to join persons in marriage shall, within sixty days after the solemnization of any marriage, lodge with the town clerk of the town in which such marriage was solemnized a certificate of such marriage in the following form, to wit:

"I hereby certify that ——, of ——, son of ——, and ——, of ——, daughter of ——, were lawfully united in marriage on the —— day of ——, by me," and pay him for recording the same the sum of ten cents, upon a penalty of five dollars for every neglect.

SEC. 2. Every parent shall lodge with the town clerk of the town in which he resides a certificate, signed by himself, of the birth of each of his children, within two months after birth, upon the penalty of one dollar for every neglect.

SEC. 3. The executor or administrator of every deceased person shall, within two months after the granting of letters testamentary or of the administration, and if the deceased be a minor, then the parent or guardian of the deceased, shall, within two

months from the death of said minor, lodge with the town clerk of the town in which deceased last dwelt a certificate in writing, under his hand, of the time of the death of the deceased, upon the penalty of one dollar.

SEC. 4. The town clerk of each town shall record the certificates of marriages, births, and deaths so lodged with him for record, in a proper book or books, to be kept for such purpose only, upon the penalty of ten dollars for each neglect.

SEC. 5. All penalties under this act may be sued for and recovered by action of debt, before any justice of the peace in the town where they are incurred, by the treasurer of said town, to and for the use of said town: *Provided, always*, That such suit be brought within two years after the right of action occurred.

Every parent is to lodge with the town clerk his certificate of the birth of each of his children, within two months after birth, under penalty of one dollar.

The executor or administrator of every deceased person shall, within two months after the granting of the letters, or if the deceased be a minor, the parent or guardian, furnish the town clerk with a certificate under penalty of a dollar. The town clerk is to record these certificates. No proviso is made for recording anything beyond the mere fact of the death, and it soon became and remained a dead letter.

In 1849 a bill was introduced making it compulsory on physicians, under heavy penalty, to furnish annually complete returns of all births and deaths occurring in their practice, such returns to be made to the president of the Rhode Island Medical Society, and that the said president should make out tabular statement and present report thereof to the general assembly. This aroused the attention of the medical society, which appointed a special committee of three to confer with the legislative committee.

The result of this conference was the passage of a law in February, 1850, providing that it should be the duty of all trustees of school districts to secure records of marriages, births, and deaths.

Not a single return required by this act was ever made, owing to the fact that the trustees of the school districts declined to undertake the duties additional to those already imposed upon and gratuitously performed by them.

In 1852 the act was amended by placing the duty of collecting the statistics on the city and town clerks.

The first annual report under this law was for the year ending May 31, 1853. These reports have regularly continued until the whole matter was placed under the direction of the secretary of the State board of health.

The matter was placed under the direction of the State board of health by act of April 12, 1878.

AN ACT in amendment of an act entitled "An act to provide for a registration of births, marriages, and deaths."

It is enacted by the general assembly as follows:

SECTION 1. The town clerks of the several towns, and the city clerk of the city of Providence, are hereby authorized and required to obtain, record, and index, as required by the forms prescribed by the third section of the act to which this is in amendment, all information concerning births, marriages, and deaths occurring amongst the inhabitants of their respective towns, and in said city, and annually to make duly certified returns thereof to the secretary of state, for each year, ending on the first day of June.

SEC. 2. It shall be the duty of the secretary of state to receive the returns made in pursuance of the preceding section, and annually, with such assistance as shall be rendered by any authorized committee of the Rhode Island Medical Society, to make and publish, not exceeding seven hundred copies, a general abstract thereof, in form as prescribed by the act to which this is in amendment.

SEC. 3. The blank forms required by the third section of the act to which this is in amendment, to be furnished as therein directed, shall hereafter be furnished by the secretary of state to clergymen, physicians, undertakers, town and city clerks, and clerks of the Society of Friends.

SEC. 4. The city and town clerks shall receive for each record of a birth, marriage, or death, made and returned as required by law, ten cents, to be paid to them out of the city and town treasuries of their respective towns: *Provided*, That the yearly compensation to any one town clerk who shall faithfully perform the duties prescribed by this act, and the act to which this is in amendment, shall not be less than five dollars.

SEC. 5. If any clergyman, physician, undertaker, town or city clerk, or clerk of any meeting of the Society of Friends shall willfully neglect or refuse to perform any of the duties imposed or required by this act, or the act to which this is in amendment, he shall, at the discretion of the court or justice trying the cause, on conviction

thereof, be fined not exceeding twenty dollars, to be recovered by complaint and warrant, one half thereof to the use of the town or city in which the offence shall occur, the other half to the person who shall prosecute for the same.

SEC. 6. This act shall go into effect from and after the first day of June next, and from and after that time all acts and parts of acts inconsistent herewith shall be deemed and taken to be repealed.

AN ACT to provide for a registration of births, marriages, and deaths.

Whereas, in the administration of justice, or upon the important subject of State pauperism (and even in the pursuits of private life), it has often been found difficult, from the death of witnesses, as well as from other causes, to prove the birth, marriage, or death of persons, whereby the rights of many have been sacrificed, and great wrongs have been inflicted upon individuals and the community; and whereas important truths deeply affecting the physical welfare of mankind are to be drawn from a knowledge of the number of births, deaths, or marriages, that, during a term of years, may occur or be contracted within the limits of a State: Therefore,

It is enacted by the general assembly as follows:

SEC. 3. The record of a birth shall state the date of the birth, place of birth, name, sex, name and surname of one or both of the parents, color, occupation of the father, residence of the parents, time of recording, so far as the same can be ascertained. The record of a marriage shall state the date of the marriage, place, name, residence, and official station of the person by whom married, names and surnames of the parties, residence of each, age of each (single or married), what marriage, second, third, &c., color, occupation, and name of their parents, and the time of recording, so far as the same can be ascertained. The record of deaths shall state the date of the death, name and surname of the deceased, the sex, color, condition (single or married), age, occupation, place of death, place of birth, names of the parents, disease or cause of death, place of birth, and the time of recording, so far as the same can be ascertained.

SEC. 4. *Of marriages.*—Every Society of Friends, clergyman, and all others authorized to join persons in marriage, shall make a faithful record of every such rite performed by them (in manner and form aforesaid), and return the same at least quarter-yearly to the city or town clerks, and no marriage shall be solemnized until the parties shall have furnished as near as may be the information hereinbefore required.

SEC. 5. *Of births.*—As a large number of births annually take place without the assistance or intervention of strictly professional aid, it shall be the duty of each and every parent to make returns to said city or town clerk of the birth of each of his children in manner and form aforesaid, at least within three months after the same shall have occurred.

SEC. 6. *Of deaths.*—It shall be the duty of each and every practising physician or surgeon, of whatever character, to keep a faithful record, and to make returns as aforsaid, of every death occurring in his or her professional practice within this State within at least three months after the same shall have occurred. If without the attend ance of a physician, the coroner shall make returns.

SEC. 7. *Of undertakers.*—There may be appointed by the city and town authorities a sufficient number of persons to act as undertakers, removable at the pleasure of said authorities, whose duty it shall be to keep a faithful record of all interments by them made and to make returns at least quarter-yearly, as aforesaid.

SEC. 8. In such cities and towns wherein no district school organization exists, said returns may be made to the city or town clerks, to be by them transmitted to the commissioner of public schools, and any city or town may enact municipal laws more effectually to obtain the objects herein contemplated: *Provided*, They do not conflict with the main and specific object of this act, viz, to procure the most perfect registration.

SEC. 10. No letters of administration or letters testamentary shall be granted by any court of probate upon the effects or estate of any person until the death of such person, or the facts from which the same is presumed, shall be duly certified, as near as may be, to the town clerk, in order that the same may be duly registered according to the provisions of this act.

SEC. 11. The said books or registers, or a certificate duly certified by the town clerk, and authenticated by his seal of office, as containing a full copy of the record of any marriage, birth, or death, shall hereafter be admitted in any court of this State as *prima facie* proof of any marriage, birth, or death.

SEC. 12. Births, marriages, and deaths of non-residents shall be distinguished from those of residents in the returns. The secretary of state may from time to time vary the forms of returns, and require such additional information as he may consider necessary to effect the object of this act.

SEC. 13. So much of any former act or acts as is inconsistent with the provisions of this act is hereby repealed.

Passed January, 1850.

AN ACT in amendment of an act entitled "An act to provide for a registration of births, marriages, and deaths."

It is enacted by the general assembly as follows:

SEC. 1. The town clerks of the several towns, and the city clerk of the city of Providence, are hereby authorized and required to obtain, record, and index, as required by the forms prescribed by the third section of the act to which this is an amendment, all information concerning births, marriages, and deaths occurring amongst the inhabitants of their respective towns and in said city, and annually to make duly certified returns thereof to the secretary of state, for each year, ending on the first day of June.

SEC. 2. It shall be the duty of the secretary of state to receive the returns made in pursuance of the preceding section, and annually, with such assistance as shall be rendered by any authorized committee of the Rhode Island Medical Society, to make and publish, not exceeding seven hundred copies, a general abstract thereof, in form as prescribed by the act to which this is an amendment.

SEC. 3. The blank forms required by the third section of the act to which this is an amendment, to be furnished as therein directed, shall hereafter be furnished by the secretary of state to clergymen, physicians, undertakers, town and city clerks, and clerks of the Society of Friends.

SEC. 4. The city and town clerks shall receive for each record of a birth, marriage, or death, made and returned as required by law, ten cents, to be paid to them out of the city and town treasuries of their respective towns: *Provided*, That the yearly compensation to any one town clerk who shall faithfully perform the duties prescribed by this act, and the act to which this is in amendment, shall not be less than five dollars.

SEC. 5. If any clergyman, physician, undertaker, town or city clerk, or clerk of any meeting of the Society of Friends, shall wilfully neglect or refuse to perform any of the duties imposed or required by this act, or the act to which this in amendment, he shall, at the discretion of the court or justice trying the cause, on conviction thereof, be fined not exceeding twenty dollars, to be recovered by complaint and warrant, one half thereof to the use of the town or city in which the offence shall occur, the other half to the person who shall prosecute for the same.

SEC. 6. This act shall go into effect from and after the first day of June next, and from and after that time all acts and parts of acts inconsistent herewith shall be deemed and taken to be repealed.

Passed January, 1852.

SOUTH CAROLINA.

The first annual report of registration of births, marriages, and deaths in South Carolina was for the year ending December 31, 1853, and the last one was for the year ending December 31, 1859, being six annual reports. In the final report the registrar, Dr. Gibbes, remarks that although an improvement is observed in the returns, yet the law is not carried out efficiently, and that Charleston especially furnished the most meager returns in the State.

An act was passed in December, 1856, making it the duty of the tax collector to require all those making tax returns to make a separate return stating number of whites, male and female, who have been born, married, or who have died during the year in their households, and the number of blacks who have been born or died, and when the tax collector neglects his duty he shall be fined $5, and any citizen refusing to obey the law shall be charged 5 per cent. on his taxes.

A registrar was to be appointed by the governor to prepare an annual report, and the tax collector was to ascertain the number of births, marriages, and deaths of non-taxpaying whites. Tax collector was also to ascertain from the magistrates, physicians, and ministers the number of births, marriages, and deaths that have taken place among their patients or congregations.

AN ACT for the establishment of a general system of registration of births, marriages, and deaths in the State of South Carolina.

I. *Be it enacted by the senate and house of representatives, now met and sitting in general assembly, and by the authority of the same,* That from and after the passage of this act it shall be the duty of the tax collectors of the different districts and parishes in this State to require of the inhabitants of the said districts and parishes, at the time of making their general tax returns, a separate return, stating the number of whites, male and female, who have been born, married, or who have died during the year in their respective households; and the number of blacks who have been born or who have died during the same period, and return the same to the comptroller-general.

II. That two registrars shall be appointed by the governor, one in Columbia and one in Charleston, whose duty it shall be to receive from the respective offices of the comptroller-general in Charleston and Columbia the returns of the tax collectors, and make and publish a full report of the same annually.

III. That in order to ascertain as accurately as possible the number of births, marriages, and deaths of non-taxpaying whites, it shall be the duty of the tax collector to ascertain from the magistrates, physicians, and ministers of the gospel of the different districts and parishes the number of births, marriages, and deaths that have taken place among the persons within their jurisdiction, or belonging to their congregations, respectively; and it shall be the duty of the registrars to draw out a proper form of registration for the tax collectors of the different districts and parishes, and for the use of the magistrates and ministers of the gospel of the said districts and parishes.

IV. That the said registrars shall each receive annually the sum of five hundred dollars.

Enacted 20 Dec., 1853.*

AN ACT for the better establishment of a general system of registration of births, marriages, and deaths in the State of South Carolina.

SECTION 1. *Be it enacted by the senate and house of representatives, now met and sitting in general assembly, and by the authority of the same,* That from and after passing of this act, it shall be the duty of the tax collectors of the different districts and parishes of this State to require of the inhabitants of the said districts and parishes, at the time of making the general tax returns, a separate return stating the number of whites, male and female, who have been born, married, or who have died during the year in their respective households, and the number of blacks who have been born, or who have died, during the same period, and return the same to the comptroller-general; and in each case in which the tax collector neglects his duty he shall be fined five dollars, and the citizen refusing charged five per cent. on his general tax.

SEC. 2. That one registrar shall be appointed by the governor, whose duty it shall be to receive from the respective offices of the comptroller-general, in Charleston and Columbia, the returns of the tax collectors, and make and publish a full report of the same annually, filing a copy of his report in the comptroller-general's office, both in Charleston and Columbia.

SEC. 3. That in order to ascertain, as accurately as possible, the number of births, marriages, and deaths of non-taxpaying whites, it shall be the duty of the tax collector to ascertain from the magistrate, physicians, and ministers of the gospel of the different districts and parishes the number of births, marriages, and deaths that have taken place among the persons within their jurisdiction, or belonging to their congregations respectively; and it shall be the duty of the registrar to draw out a proper form of registration for the tax collectors of the different districts and parishes, and for the use of the magistrates and ministers of the gospel of the said districts and parishes.

SEC. 4. That the said registrar shall receive annually the sum of four hundred dollars for his services.

SEC. 5. That the tax collectors shall be entitled to retain out of the taxes collected by them three cents for the entry of each birth, death, or marriage required by this act.

In the senate house, the twentieth day of December, in the year of our Lord one thousand eight hundred and fifty-six, and in the eighty-first year of the sovereignty and independence of the United States of America.

JAMES CHESNUT, JR.,
President of the Senate.
JAMES SIMONS,
Speaker of the House of Representatives.

AN ACT to alter and amend the law in relation to the registration of births, marriages, and deaths.

I. *Be it enacted by the Senate and House of Representatives, now met and sitting in general assembly, and by authority of the same,* That it shall be the duty of all magistrates, clergymen, and others who perform marriage ceremony in South Carolina, to keep a registry of all marriages celebrated by them, together with date, names, ages, residence, and nativity of parties.

II. That it shall be the duty of all physicians and midwives to keep a registry of all births and deaths at which they have attended professionally, which registry shall show, in case of *white births*, the time and place, names and residence of parents, sex and name of child (if it have the latter), and whether born alive or dead; in case of

* See 12 Statutes at Large of South Carolina, page 300.

deaths of whites, the date, place, and cause of death, name, age, sex, whether single or married, occupation, residence, and nativity of the deceased, with names and surnames of parents; in case of *births and deaths of slaves* the same items, together with the name of the owner, instead of name of the deceased and the names of parents.

III. That it shall be the duty of all physicians, clergymen, and midwives to deliver to the tax collector of the district in which such births occur, while he is collecting taxes in every year, the said registries or copies of them embracing the period of one year, ending on the thirty-first day of December preceding.

IV. That it shall be the duty of each tax collector, while attending to the other business of his office, to ascertain, number, and record, in the order in which they are received (in blank-books to be furnished him for that purpose), all the births, marriages, and deaths which have occurred in the district during the year preceding the first day of January previous, with all the items as inserted in the registries above named. He shall make strict inquiry of individuals and heads of families, and also make use of the registries of physicians above named in order to obtain the correct information and complete his lists; after completion of said lists the tax collector shall make out and attach thereto a complete alphabetical index of the same, and he shall return on oath the books containing said records and index to the comptroller-general at the time when he makes his general tax returns.

V. That the tax collectors shall be entitled to retain, out of the taxes collected by them, five cents for collecting, recording, and indexing a complete return of each birth, death, and marriage required by this act.

VI. That any citizen refusing to give the necessary information, and any tax collector, clergyman, physician, magistrate, or midwife refusing to comply with the requisitions of this act, shall be fined for each offence ten dollars, which fine shall be recovered by any person who shall sue befor a magistrate for the same, one half thereof to the use of the said complainant, and the other half to the State.

VII. That it shall be the duty of the governor to appoint a registrar, under whose order the necessary registry blanks and books, together with such printed instructions as he may deem proper, shall be prepared and furnished at the expense of the State to the different tax collectors. It shall be the duty of the registrar also to receive from the respective offices of the comptroller-general in Charleston and Columbia the returns of the tax collectors, and to prepare a report therefrom containing tabular statements, which shall show, in a condensed form, the information required to be preserved, keeping the statistics of each district separate, together with practical observation upon said tables, and to cause one thousand copies of said report to be printed in pamphlet form on or before the fourth Monday in November in every year, filing a copy in each comptroller's office, and delivering to each tax collector a copy also.

VIII. That the salary of the registrar shall be five hundred dollars per annum for the services of himself and such clerks as he may find necessary.

IX. That it shall be the duty of the registrar also to return the registry books to the comptroller after said report is printed, and the comptroller shall have those of each year bound together in volumes, to be preserved thereafter in his office for further reference.

X. That a duly certified copy of any return of birth, death, or marriage, given by the comptroller or his deputy, shall hereafter be admitted and received in all courts of this State as *prima facie* evidence of any such birth, death, or marriage recorded or so certified. For each certificate of birth, death, or marriage the comptroller shall be entitled to a fee of one dollar, to be paid by the party applying for it.

In the senate house, the twenty-first day of December, in the year of our Lord one thousand eight hundred and fifty-eight, and in the eighty third year of the sovereignty and independence of the United States of America.

WILLIAM D. PORTER,
President of the Senate.
JAMES SIMONS,
Speaker House of Representatives.

TENNESSEE.

[Statutes of Tennessee, 1872–'73.]

SEC. 2439. All regular ministers of the gospel of every denomination having the care of souls, and all justices of the peace, judges, and chancellors in the State, may solemnize the rite of matrimony. (Act of 1778.)

SEC. 2441. Before being joined in marriage the parties shall produce to the minister or officer aforesaid a license under the hand of the county clerk of the county court where the female resides or where the marriage is solemnized, directed to such minister or officer, authorizing the solemnization of a marriage between said parties.

SEC. 2444. The clerk shall at the foot or on the back of each license place the following form of certificate, to be signed by the person solemnizing the marriage:

"I solemnized the rite of matrimony between the above (or within) named parties on the —— day of ———, 18—."

SEC. 2447. It shall be the duty of the officer or minister who has solemnized such marriages to return the certificate of the marriages to the office of the county clerk of the proper county, and for a failure thereof he shall be liable to indictment or presentment for a misdemeanor, and this act to take effect from its passage (1865).

[Act approved March 26, 1877.]

AN ACT to create a State board of health for the better protection of life and health and the prevention of the spread of diseases in the State of Tennessee.

SEC. 6. *Be it further enacted*, That the State board of health shall have general supervision of the interests of health and life of the citizens of this State. They shall especially study the vital statistics of this State and endeavor to make intelligent and profitable use of the records of sickness and death among the people. * * *

SEC. 7. *Be it further enacted*, That in order to afford to this board better advantage for obtaining knowledge important to be incorporated with that collected through special investigations and from other sources, it is hereby made obligatory upon every municipality throughout the State having five thousand and over inhabitants to organize within 60 days after the passage of this act, provided said municipalities have not already done so, a properly constituted board of health, which, in addition to their duties as such local boards, shall also make monthly, quarterly, semi-annual, and annual reports to and in accordance with such form and instructions as said State board of health may prescribe, and also shall make special reports whenever required. * * *

The law relating to marriage licenses enacted by the legislature of North Carolina in 1778 is still operative in Tennessee, viz:

"Before being joined in marriage the parties shall produce to the minister or officer aforesaid—'all justices of the peace, judges, and chancellors in the State may solomnize the rite of matrimony'—a license under the hand of the clerk of the county court where the female resides, or where the marriage is solemnized, directed to such minister or officer, authorizing the solemnization of a marriage between said parties." [Act 1778, ch. 7, secs. 2 and 3.]

This was amended by the legislature of Tennessee in 1815 and 1838 as follows:

"The minister of the gospel, or justice of the peace, or judge or chancellor, who solemnizes the rite of matrimony, shall indorse on or append to the license the time of marriage, and sign his name thereto, and return the license to the clerk of the county court within six months thereafter.

"The clerk shall, at the foot or back of each license, place the following form of certificate, to be signed by the person solemnizing the marriage:

"I solemnized the rite of matrimony between the above (or within) named parties on the —— day of ———, 18—.

"It shall be the duty of the clerk to register, in a well-bound book, the names of the parties and the date of the issuance of a marriage license, and to copy immediately under or opposite thereto, the return of the proper functionary who solemnized the rites of matrimony, and the date thereof, and file and retain the license and return thereof in his office." [Acts 1815, ch. 47; 1838, ch. 118.]

It was also again amended in 1865–'66, as follows:

"It shall be the duty of the officer or minister who has solemnized such marriages to return the certificate of the marriages to the office of the county court clerk of the proper county, and for a failure thereof he shall be liable to indictment or presentment for a misdemeanor, and this act to take effect from its passage. [Act 1865–'66, ch. 58, sec. 2.]

Registration law.

AN ACT to provide for the registration of births, marriages, and deaths in Tennessee.

SECTION 1. *Be it enacted by the general assembly of the State of Tennessee*, That every justice of the peace, minister of the gospel, and all other legally authorized persons solemnizing marriage in this State, shall make a record of each marriage so solemnized by him, together with all the facts relating to the same, as required by the fifth section of this act; and such justice, minister of the gospel, or other person, shall, at the time such marriage is solemnized, deliver on demand to either of the parties so joined in marriage as aforesaid a certificate of such marriage, containing all the

facts thereto required by said fifth section of this act, and shall, within thirty days thereafter, deliver to the clerk of the county court in which such marriage took place a certified copy of such record.

SEC. 2. That every physician, surgeon, and midwife, who may be in professional attendance at any birth or death in this state, or in the absence of any or all of the aforesaid parties the head of or senior member of said household wherein said birth or death occurred, shall, within thirty (30) days thereafter, file a written statement, duly certified to, of the fact, together with such other facts pertaining thereto, as are required in section five (5) of this act, with the senior (by age) justice of the peace of the civil district in which said birth or death occurred.

SEC. 3. It shall be the duty of the aforesaid justice of the peace in each civil district in the State, on receiving the returns of such birth or deaths, to record the same in a book to be furnished by the county, properly ruled in the order in which they are received by said justice, and once within each and every thirty days make and deliver to the county court clerk of the county in which such civil district is located a certified copy of such record.

SEC. 4. It shall be the duty of every coroner in this State to keep, in a well-bound book, a record of every inquest held in his district, and within thirty days after the holding of such inquest he shall deliver to the county court clerk of the county wherein said coroner has jurisdiction a certified copy of such record, giving all the facts as required in section five (5) of this act for other deaths.

SEC. 5. It shall be the duty of the county court clerk of the several counties in this State, on receiving the returns of such births, marriages, and deaths, to record the same at length in separate books (well bound) to be provided by the county for that purpose, with proper indexes thereto. The births, marriages, and deaths shall be numbered and recorded in the order in which they are received by the said clerk, and the record of marriages shall be indexed, using both the name of bridegroom and bride. The record of births shall state, in separate columns, the date of the birth, the name of the child (if it have any), the sex and color of the child, the place of birth, the christian and surname of both parents, the residence and nativity of the parents, the occupation of the father, and the date when the record was made: *Provided*, That in case the child has no christian name, such name shall be obtained and reported by the head of the household wherein said birth occurred, within thirty days after his or her attention has been called to the fact by the senior (by age) justice of the peace, who shall do so *at once* upon discovering the omission, and such christian name shall be distinctly designated in such report as the christian name belonging to a child previously reported, and shall be properly entered by said justice in the blank left for such christian name in his book of record.

The record of marriages shall state, in separate columns, the date and place of marriage, the christian and surname of the bridegroom and bride, and the maiden name of the bride, if a widow, the color, age, and place of birth of each, the residence of each at the time of marriage, the occupation of the bridegroom and the name and official station of the person by or before whom they were married, the name and residence of at least two witnesses present at such marriage, and the date when such record was made.

The record of deaths shall state, in separate columns, the date of the death, the christian and surname of the deceased, the sex and color, whether married or single, the age in years, months and days, the place of death, the disease or apparent cause of death, the nativity of the deceased and the occupation, if any, and the names and residence of the parents, if known, and the date when such record was made.

The clerk of the county court of the several counties shall annually, on or before the 1st day of April, make and transmit to the secretary of state a certified copy of the records of his office of all the births, marriages, and deaths reported in their respective counties for the year ending December 31, last preceding.

And each county court clerk shall receive for the record of each birth, marriage, and death in his office three cents; and three cents for each birth, marriage, and death returned by him to the secretary of state, to be paid by the county upon the presentation of a certificate from the secretary of state that the duties herein imposed upon said county court clerks have been performed, and shall be compensation for all services required by this act to be performed by him.

SEC. 6. It shall be the duty of the secretary of state to receive the returns made in pursuance of the fifth section of this act, and he shall cause the same for each year to be bound together in one or more volumes at the expense of the State, and make indexes thereto, and with the assistance of the secretary of the State board of health, who is hereby constituted *ex-officio* "the superintendent of vital statistics," shall prepare such tabular statements, results, and deductions therefrom as will render them of practical utility, and make report thereof annually to the governor of the State, which report may be ordered published and distributed in such manner as the legislature may from time to time direct.

SEC. 7. Nothing contained in this act shall be so construed as interfering with the

manner adopted at the time of the passage of this act by any municipality in this State for collecting such vital statistics, and it is hereby made the duty of every such municipality to cause to be made once in every thirty days a transcript of such municipal record, which, after being duly certified to, they shall cause the same to be delivered to the clerk of the county court in which county said municipality is located.

SEC. 8. In case of the refusal or neglect, by any of the officers or individuals mentioned in this act to perform any of the duties hereinbefore required of them, or either of them, to be done and performed by any of the provisions herein contained, such officer or person shall be guilty of a misdemeanor, and upon conviction shall be fined not less than five nor more than fifty dollars, and the prosecuting attorney in each county or judicial district of the State is hereby required to prosecute, in the name of the people of the State of Tennessee, all persons in his county or judicial district who shall violate any of the provisions of this act.

SEC. 9. *Be it further enacted*, That all laws or parts of laws coming in conflict with this act be, and are hereby, repealed, and that this act take effect from and after its passage, the public welfare requiring it.

Approved April 5, 1881.

TEXAS.

[Revised Statutes of Texas, 1879.]

ART. 407. [*Cities and towns—general powers and duties of city councils*]. To regulate the burial of the dead; to purchase one or more cemeteries; to regulate the registration of deaths, marriages, and births; to direct the returning and keeping of bills of mortality.

ART. 1149. [*The clerk of the county court.*] Such clerks shall also be authorized to issue all marriage licenses. * * *

ART. 2838. [*Husband and wife.*] All regularly licensed or ordained ministers of the Gospel, judges of the district and county courts, and all justices of the peace of the several counties are authorized to celebrate the rites of matrimony between all persons legally authorized to marry.

2839. Males under sixteen and females under fourteen shall not marry.

2840. Any person desiring to marry shall apply to the clerk of the county court, and shall receive from him a license directed to all persons authorized by law to celebrate the rites of matrimony, which shall be sufficient authority for any one of such persons to celebrate such marriage.

2841. No clerk shall issue a license without the consent of the parents or guardians of the parties applying unless the parties so applying shall be in the case of the male twenty-one years of age and in the female eighteen years of age.

2842. The said clerk shall record all licenses so issued by him, in a well-bound book kept for that purpose; and it shall be the duty of the persons solemnizing the rites of matrimony, to indorse the same on the license and make return of the same to the office of the clerk of the county court within 60 days after the celebration as aforesaid; which return shall also be recorded as aforesaid.

2843. It shall not be lawful for any person of European blood or their descendants to intermarry with Africans or the descendants of Africans; and should any person as aforesaid violate the provisions of this article such marriage shall be null and void.

VERMONT.

The first annual report of registration was for the year ending December 31, 1857.

The record books and blanks were prepared under the direction of H. F. Stevens, of Saint Albans, who was the chief promoter of the passage of the act.

The act for registration was approved November 17, 1856, and subsequently amended as to minor details by act approved October 30, 1857.

REGISTRATION.

[Chapter 128 of the Revised Laws of Vermont.]

Registration of births, marriages, divorces, and deaths.

DUTIES OF SCHOOL DISTRICT CLERKS.

SEC. 2547. The school district clerks in each town, or in towns not divided into districts the clerk of the school board, shall annually, in the month of January, ascer-

tain the births and deaths which occurred in their respective districts, during the year next preceding the first day of January; and shall report to the town clerk, on or before the first day of February, the date and place of birth of each child, its name and sex, the name and residence of its parents, and the occupation of its father. They shall also report the date, place, and disease or apparent cause of each death, the name and sex of the deceased, whether married or single, his age in years, months, and days, place of birth, the name of his parents, and his occupation, if over fifteen years of age.

SEC. 2548. If a district clerk or clerk of school board fails to make the required return, or makes an incomplete or incorrect return, he shall forfeit all compensation therefor and be fined not less than five dollars; and the town clerk shall forthwith cause prosecution to be commenced against him in the name of the State, to recover such penalty.

SEC. 2549. So much of this chapter as relates to the duties of school district clerks, in collecting and making returns of births and deaths, shall not apply to the city of Burlington.

DUTIES OF TOWN CLERKS.

SEC. 2550. Town clerks shall carefully examine the returns of births and deaths made to them by the clerks of the several school districts, and if the returns are made up up and returned agreeably to law, they shall furnish the school district clerk so complying with the requirements of law a certificate to that effect; and on presentation of such certificate to the selectmen, they shall draw an order on the town treasurer to pay such school district clerk or clerk of school board fifteen cents for each birth or death returned.

SEC. 2551. Town clerks shall number and record in the order in which they are received, the returns of births, marriages, and deaths made to them, and the record shall show the time when it was made. They shall annually, in the month of March, transmit to the secretary of state a certified copy of such record made for the year next preceding the first day of January.

SEC. 2552. The clerk of each town shall receive from the treasury of the town five cents for recording each birth and death and ten cents a folio for copying the same and the marriage records in his office for the use of the secretary of state, provided said clerks comply with the provisions of this chapter in all respects.

SEC. 2553. If a town clerk fails to comply with the requirements of law in relation to making returns of births, marriages, and deaths to the secretary of state, he shall be fined not less than twenty dollars.

DUTIES OF COUNTY CLERKS.

SEC. 2554. The clerks of the county courts shall, on the last day of December in each year, make return to the secretary of state of the number of divorces granted in their respective counties during the year ending on that day.

DUTIES OF THE SECRETARY OF STATE.

SEC. 2555. The secretary of state shall prepare and furnish to town clerks blank forms to be used as books of records according to the provisions of this chapter, and also blank forms of returns, and shall accompany the same with the necessary instructions and explanations; and the town clerks shall distribute the same as directed by the secretary.

SEC. 2556. The secretary of state shall receive the returns made to him in pursuance of this chapter, and cause the same to be bound in one or more volumes, with indexes thereto; and with such assistance as is voluntarily rendered by any committee appointed by the Vermont Medical Society for that purpose, prepare therefrom such tabular results as will render them of practical utility, and make a report thereof biennially to the general assembly; and one thousand copies of the report shall be biennially published in cloth.

SEC. 2557. The secretary of state shall cause prosecutions to be commenced in the name of the State in an action on the case, founded on this chapter, to recover any penalty or forfeiture imposed by the provisions therein, whose recovery is not otherwise provided for.

MISCELLANEOUS.

SEC. 2558. A physician who attended upon a deceased person, shall leave with the town clerk a certificate containing the name of the disease or the cause of such death within fifteen days after the interment of the deceased; and a medical attendant who fails to give such certificate shall be fined three dollars for the use of the town where the offence is committed.

SEC. 2559. When a male resident of this State is married without the State, he shall, within sixty days, deposit with the clerk of the town where he resides, a certificate embracing the statistics required by law in marriage certificates, and if he does not deposit such certificate, he shall forfeit not less than ten dollars.

SEC. 2560. The head of a family, who moves into and becomes a permanent resident of this State, may cause to be recorded in the office of the clerk of the town where such residence is, a certificate of his marriage embracing the statistics required by law, and may also cause to be recorded the birth of any of his children, born without the State, with the statistics relating to such births required by law, and shall make oath to the correctness of such statistics. But such record shall not be returned to the secretary of state.

SEC. 2561. Town clerks shall record matter submitted to them for record under the two preceding sections, and shall receive the same fees for such record as provided by law for similar records.

VIRGINIA.

Registration act.

AN ACT concerning the registration of births, marriages, and deaths, passed by the general assembly of Virginia April 11, 1853.

1. *Be it enacted by the general assembly,* That from and after the first day of January, eighteen hundred and fifty-four, the clerk of every county and corporation court shall keep three books, to be called, respectively, the register of marriages, the register of births, and the register of deaths.

2. Henceforth it shall be the duty of every minister, or other person celebrating a marriage, and of the clerk or keeper of the records of any religious society which solemnizes marriages by the consent of the parties in open congregation, at once to make a record of every marriage between white persons solemnized by or before him, and within two months after such marriage to return a certificate thereof, signed by him, to the clerk of the court of the county or corporation in which the same is solemnized. Such record and certificate shall set forth, as far as the same can be ascertained, the date and place of the marriage, the full names of both parties, their ages and condition before the marriage (whether single or widowed), the places of their birth and residence, the names of their parents, and the occupation of the husband.

3. The clerk to whom such certificate shall be returned shall file and preserve the same in his office, and within twenty days after receiving the same record a full abstract thereof in his register of marriages, setting out in convenient tabular form all the circumstances therein stated and the name of the person signing the certificate, and make an index of the names of both the parties married.

4. If at the time of celebrating any marriage out of this State either or both of the parties thereto be a resident or residents of this State, a certificate or statement thereof, verified by the affidavit of any person present at such celebration, may be returned to the clerk of the court of the county or corporation in which the husband resides, if he be such a resident, and otherwise of the county or corporation in which the wife resides; and an abstract thereof shall be recorded by him in the manner prescribed in the third section.

5. If any minister who shall give bond, in order to his being authorized to celebrate marriage in this State, shall fail to comply with the second section, the condition of such bond shall be deemed to be thereby broken, and he shall also be subject to the penalty hereinafter prescribed for such failure.

6. Every such clerk of a court shall, on or before the first day of the next November term of his court, post at the front door of his court-house a copy of the second section, with a statement of the penalties for violations thereof.

7. Every commissioner of the revenue shall make an annual registration of the births and deaths in his district. When he ascertains the personal property subject to taxation he shall ascertain the births and deaths that have occurred in the year ending on the thirty-first day of December preceding, and such circumstances as he is hereinafter required to record. He shall ascertain the births and deaths in each family from the head of such family, if practicable.

8. He shall record in a book to be kept by him for that purpose, so far as can be ascertained, the date and place of every such birth; the full name of the child (if it has a name); the sex and color thereof, and, if colored, whether free or slave; whether the child was born alive or still-born; the full name of the mother, and, if the child be free and born in wedlock, the full name, occupation, and residence of the father; if the child be a slave, the name of the owner; if there be more than one child born at one birth, the fact and number shall be stated, and any other circumstances of interest relating to any birth.

9. Every such commissioner shall in like manner record, in a book to be kept by him for that purpose, the place and date of every death in his district during the year ending on the preceding thirty-first day of December; the full name, sex, age, condition (whether married or not), and color of the deceased, and, if colored, whether free or slave; also, the occupation, if any, of the deceased, and his or her place of birth; the names of his or her parents, and (if the deceased was married) the name of the husband or wife; and, if the deceased was a slave, the name of the owner; also, the disease or cause of the death, so far as such facts can be ascertained.

10. The commissioners shall make and subscribe an affidavit upon each of the books so to be kept by him to the effect that he has pursued the directions in this act, according to the best of his skill; and he shall return his said books to the clerk of the court of his county or corporation on or before the first day of June.

11. Such clerk shall thereupon record a full abstract of the contents of the said book, containing a record of births, in his said register of births, setting forth, in convenient tabular form, all the circumstances hereinbefore required to be recorded, with references to the commissioners' book, and making an alphabetical index of the names of the free children born, and (when they have no names) of the names of the parents, and also of the owners of the slaves born, placing in the index the dates of the births.

12. He shall in like manner record a full abstract of the contents of the said book, containing a record of deaths, in his said register of deaths, setting forth, in convenient tabular form, all the circumstances hereinbefore required to be recorded, with reference to the commissioners' books, and making an alphabetical index of the names of the deceased and the names of the owners of the deceased slaves, and placing in the index the dates of the deaths.

13. Every such clerk of a court shall file and preserve in his office the books so deposited with him by the commissioners.

14. He shall transmit to the auditor of public accounts a copy of his register of marriages during the preceding year, on or before the first day of March in each year, and a copy of his register of births and register of deaths during the preceding year, on or before the first day of August in each year.

15. Such copies shall be filed and preserved in the said auditor's office, and from them the auditor shall prepare an abstract annually of marriages, births, and deaths in each county and corporation, and make a report upon said registrations once in every period of two years, to be laid before the general assembly.

16. The said books to be kept by the clerks, and copies (or of any part thereof) certified by the clerk lawfully having the custody thereof, shall be prima facie evidence of the facts therein set forth in all cases.

17. A clerk shall be entitled to ten cents for every copy of an entry in said books relating to marriage, birth, or death, to be paid by the party requiring the copy.

18. If a commissioner in any case cannot obtain the requisite information concerning any birth or death from the head of family, as before required, he shall obtain the same from such persons as are hereinafter required to give it; or if that cannot be done, from any other persons, always recording the name of the person giving the information.

19. Every physician and surgeon shall, in a book to be kept by him, make a record at once of the death of every person dying in this State, upon whom he has attended at the time of such death, setting out as far as practicable the circumstances herein required to be recorded by a commissioner respecting deaths. He shall give to a commissioner of the revenue, whenever called upon by him for that purpose, annually, a copy of such record, so far as the same relates to death in such commissioner's district.

20. Every person shall keep a like record of the deaths in relation to which he acts officially, and give a copy thereof to any commissioner of the revenue whenever called on by him for that purpose, annually, so far as the same relates to deaths in such commissioner's district. For every neglect or failure to perform any duty required of him by this section, a coroner shall forfeit twenty dollars.

21. The commissioner shall make such entries or corrections in his record of deaths as may be supplied or warranted by the copies, so to be furnished to him by physicians, surgeons, and coroners, noting the source of the information.

22. The head of any family, if he be not at his residence when the commissioner calls there to obtain the information required by this act to be obtained of him, shall give the same information to the proper commissioner of the revenue on or before the first day of June in the same year; and for failure or neglect to do so, shall forfeit one dollar. If any head of a family, being lawfully requested to give any such information, shall refuse to give the same, he shall forfeit ten dollars.

23. If any commissioner of the revenue fail to obtain any information respecting a birth or death, which he is by this act authorized or required to obtain, and which he can procure, he shall for every such failure, and for failure to record the information acquired by him respecting a birth or death, according to this act, forfeit five dollars.

24. If any commissioner of the revenue fail to perform the duties required of him by the tenth section of this act, he shall forfeit fifty dollars.

25. If any clerk of a court fail to perform any duty required of him by the third section of this act, he shall forfeit ten dollars for every such offence; and if he fail to perform any duty required of him by the eleventh, twelfth, thirteenth, or fourteenth section, he shall, for every such offence, forfeit fifty dollars.

26. If any clerk of a court, commissioner of the revenue, physician, surgeon, coroner, or minister celebrating a marriage, or clerk or keeper of the records of any religious society, shall in any book, register, or record, which such officer or person is by this act required to keep or make, or in any copy or certificate which by this act he is required to make or give, knowingly make any false, erroneous, or fraudulent entry, record, registration, or written statement, he shall for every offence forfeit not less than one hundred nor more than five hundred dollars.

27. If any person, upon whose information or statement any record or registration may lawfully be made under this act, shall knowingly give any false information or make any false statement to be used for the purpose of making any such record or registration, he shall forfeit not less than fifty nor more than three hundred dollars for every such offence.

28. The auditor of public accounts shall furnish the clerk of every county and corporation court and every commissioner of the revenue with all forms and instructions which he may deem necessary or proper for carrying this act into effect.

29. This act shall take effect on the first day of July, eighteen hundred and fifty-three.

The Virginia Medical Journal for July, 1856, contains some remarks by Dr. L. S. Jaynes on the report of the auditor of public accounts, relative to registration of births, marriages, and deaths. This report, it would seem, contains an abstract of the returns and deaths received at the auditor's office for 1853–'54.

Dr. Jaynes remarks that the plan proposed for the restoration act was altered by the legislature by striking from it every provision attaching compensation to the functionaries upon whom it imposed new duties. The only incentive held out for the execution of the provisions were penalties for failure to comply. The consequence was that in 1853, returns of births and marriages were received from 114 counties and corporations, leaving 36 without returns, and in 1854 returns were furnished from only 74, less than one-half the entire number. The auditor's report contains no information relative to the ages or occupation of those who died, causes of deaths, or the numbers of deaths occurring in different months of the year. In 1855 it would seem there was an act passed awarding some compensation to the commissioners and clerks. It allowed commissioners three cents for each birth and death. It was intended that the clerk should receive the same fee for recording each birth, death, and marriage, but by an oversight two bills were passed for the benefit of the clerks, one originating in the senate and the other in the house, one allowing the clerk three cents from the treasury, and the other the same from the county levy.

The fees proposed in the bill presented to the legislature by committee of the Medical Society of Virginia was ten cents to the commissioner and the same to the clerk for each fact ascertained and recorded.

WISCONSIN.

[Chap. 47, Revised Statutes of 1878.]

Of the registration of marriages, births, and deaths.

SECTION 1022. Every person or society authorized by law to solemnize marriages, by or before whom any marriage may be solemnized or contracted, shall at once make a record of the same in a book therefor, which shall contain, as far as the same can be ascertained, the full name of the husband, his occupation, place of birth and residence, full name of wife previous to marriage, names of parents of husband and of wife, the color of the parties, the time and place, when and where, and ceremony by which such marriage was contracted, and if solemnized by any clergyman or other person, his place of residence; and shall, within thirty days after such marriage, return the same facts in the form of a certificate, duly signed and dated, to the register of deeds of the county in which such marriage was contracted; and if he shall neglect to return the same as above provided, he shall forfeit for every such neglect not less than twenty-five nor more than one hundred dollars: provided, that action therefor shall have been commenced before such certificate of marriage shall have been actually delivered to the register of deeds of the proper county.

SEC. 1023. Every physician or other professional person under whose care a birth shall take place, shall at once make a record thereof in a book therefor, which shall

contain, as far as can be ascertained, the full name of the child, if any shall have been conferred, its sex, color, names of any other child or children of the same parents living, full name and occupation of the father, full name of mother previous to marriage, the day, hour, and place in and at which such birth occurred; and shall within thirty days after such birth return the same facts in the form of a certificate, duly dated and signed by him, to the register of deeds of the county in which such birth shall have taken place. In case any birth shall occur without the care of a physician or other professional person, and no physician or other such person shall be in attendance professionally upon the mother immediately thereafter, the parent or parents of such child shall certify and make return of such birth to the register in the manner and form and within the period above required.

SEC. 1024. Every physician or surgeon, who shall be in attendance professionally at the time of the death of any person, shall at once make a record of such death in a book therefor; which record shall, so far as can be ascertained, contain the full name, sex, color, age, occupation, place of birth, name of parents, time and place of death, and the disease or cause of death, and, if within his knowledge, the name of the burial ground in which interred, and if married at the time of such death, the name of the husband or wife; and shall, within thirty days after such death, return the same facts in the form of a certificate, duly dated and signed by him, to the register of deeds of the county in which such death shall have occurred.

SEC. 1025. Every register of deeds shall keep a register of marriages, births, and deaths in separate books furnished by the secretary of state. The titles of each such register shall be printed upon the top or margin of the page, and shall consist of the following, to wit:

1. Full name of husband.
2. Name of father of husband.
3. Name of mother of husband.
4. Occupation of husband.
5. Residence of husband.
6. Birthplace of husband.
7. Full name of wife previous to marriage.
8. Name of father of wife.
9. Name of mother of wife.
10. Time when the marriage was contracted.
11. The place, town or township, and county where the marriage was contracted.
12. The color.
13. By what ceremony contracted.
14. Name of person pronouncing marriage.
15. Residence of person last named.
16. Name of subscribing witnesses.
17. Date of certificate.
18. Date of registration.

For registering births:

1. Full name of child.
2. Sex.
3. Color.
4. Name of other issue living.
5. Full name of father.
6. Occupation of father.
7. Name of mother previous to marriage.
8. Hour, day of week, of month, and year of birth.
9. Place, town or township, and county in which born.
10. Name of physician or other person signing the certificate, or on whose application registry is made.
11. Residence of such person.
12. Date of certificate.
13. Date of registration.
14. Any additional circumstance.

For registering deaths:

1. Full name of deceased.
2. Color.
3. Sex.
4. Age.
5. Name of father of deceased.
6. Name of mother of deceased.
7. Occupation.
8. Place of birth.
9. Name of wife of deceased.
10. Name of husband of deceased.
11. Date of birth, and date of death.
12. Cause of death.

13. Name of the place, town or township, or county in which the person died.
14. Name and location of burial ground in which interred.
15. Name of person returning certificate.
16. Residence of such person.
17. Date of certificate.
18. Date of registration.

At the bottom of each page there shall be a blank for the registry of any fact hereafter required to be registered, and on which all interlineations shall be noted.

SEC. 1026. Each register of deeds shall record in such books and in the proper blanks, and shall file in his office all certificates of marriages, births, and deaths, returned to him pursuant to law; and he shall keep a general index to all such records in a separate book, in which he shall enter in alphabetical order the name, the page of the record, and date of the marriage, birth, or death of each person therein recorded. Each register shall annually in the month of January transmit upon suitable blanks, to be furnished by the secretary of state, a copy of the record of such marriages, births, and deaths, duly certified by him, to the secretary of state, who shall file and record the same. And said secretary of state shall, at the time of furnishing the records and blanks required to be furnished by this chapter, accompany the same with such instructions as he may see fit to prepare, for the purpose of more fully carrying into effect the provisions of this chapter.

SEC. 1027. When any marriage, birth, or death heretofore or hereafter occurring in this State shall not have been returned and registered in the manner hereinbefore provided; or when any person may have married, been born, or died elsewhere, who was a child of citizens of this State; or when any person so married elsewhere was before or at the time of such marriage, or subsequently thereto shall have become a resident of this State; or when a person born elsewhere shall have subsequently become a resident of this State, upon presenting and filing with the proper register of deeds, proof as follows, viz: in case of marriage, the affidavit of the person who performed the ceremony, or, if such proof cannot be made, then the affidavit of some person not a party to the marriage, who was present thereat; in case of birth the affidavit of some person who has actual knowledge of the time of such birth, and of his parentage; and in case of death, the affidavit of some person who knew the deceased while living, and actually saw him dead, or has actual knowledge of his death; and in each case such affidavit shall set forth, if within the knowledge of the person making the same, all the facts necessary to enable the register to make a complete register of such marriage, birth, or death in the manner hereinbefore required; and if not within his knowledge, such facts may be proved by the affidavits of others having such knowledge; such register shall register every such marriage, birth, and death, as in other cases, and if all the facts required to be entered in the register cannot be proved, he shall, notwithstanding, enter in the register such facts as are satisfactorily proven. Any person aggrieved by the decision of the register, denying any such application for registration, may appeal to the circuit court of the proper county, by giving notice thereof to such register, who shall thereupon return the testimony taken, and his reasons in writing for such decision. On such appeal the circuit court may summarily review and decide such matter.

SEC. 1028. Every physician or surgeon, or other professional person, under whose care a birth shall take place, or who shall be present professionally at any death, who shall neglect to make and return any certificate required to be made by sections one thousand and twenty-three and one thousand and twenty-four, shall for every such neglect forfeit not less than fifty nor more than one hundred dollars: provided, that an action therefor shall have been commenced before such certificate shall have been actually delivered to the register of deeds of the proper county; and any register of deeds who shall not, within fourteen days after receiving any certificate of marriage, birth, or death, or after an application made to him, unless he shall deny the same, as provided in section one thousand and twenty-seven, register in the proper form and book, any such marriage, birth, or death, shall forfeit for every such neglect twenty-five dollars.

SEC. 1029. Every register of deeds is authorized to administer oaths for all the purposes of this chapter.

ENGLISH REGISTRATION ACTS.

AN ACT for registering births, deaths, and marriages in England.

(August 17, 1836.)

XIX. *And be it enacted,* That the father or mother of any child born, or the occupier of every house or tenement in England in which any birth or death shall happen, after the said first day of March, may within forty-two days next after the day of

such birth, or within five days after the day of such death, respectively, give notice of such birth or death to the registrar of the district; and in case any new-born child or any dead body shall be found exposed the overseers of the poor in the case of the new-born child, and the coroner in the case of the dead body, shall forthwith give notice and information thereof, and of the place where such child or dead body was found, to the registrar; and for the purposes of this act the master or keeper of every gaol, prison, or house of correction or workhouse, hospital, or lunatic asylum or public or charitable institution, shall be deemed the occupier thereof.

XX. *And be it enacted*, That the father or mother of every child born in England after the said first day of March, or in case of the death, illness, absence, or inability of the father and mother, the occupier of the house or tenement in which such child shall have been born, shall within forty-two days next after the day of every such birth, give information, upon being requested so to do, to the said registrar, according to the best of his or her knowledge and belielf, of the several particulars hereby required to be known and registered touching the birth of such child.

XXI. *And be it enacted*, That if any child of an English parent shall be born at sea on board of a British vessel, the captain or commanding officer of the vessel on board of which the said child shall have been born shall forthwith make a minute of the several particulars hereinbefore required to be inserted in the register touching the birth of such child, so far as the same may be known, and the name of the vessel wherein the birth took place, and shall on the arrival of such vessel in any port of the United Kingdom, or by any other sooner opportunity, send a certificate of the said minute through the post-office to the registrar general, who shall file the same, and enter a copy thereof under his hand in a book to be kept for that purpose in "the general register office," to be called the "marine register book," and shall keep the said book with the other registers according to the provisions of this act.

XXII. *And be it enacted*, That after the expiration of forty-two days following the day of the birth of any child it shall not be lawful for any registrar to register such birth, save as hereinafter is next mentioned: Provided, That, in case the birth of any child shall not have been registered according to the provisions hereinbefore contained, it shall be lawful for any person present at the birth of such child, or for the father or guardian thereof, at any time within six calendar months next after the birth, to make a solemn declaration of the particulars required to be known, touching the birth of such child, according to the best of his or her knowledge and belief, and it shall thereupon be lawful for the said registrar then and there, in the presence of the superintendent registrar, to register the birth of the said child according to the information of the person making the said declaration; and in every such case the superintendent registrar before whom the said declaration is made shall sign the entry of the birth as well as the registrar, and for every such registry as last aforesaid the superintendent registrar shall be entitled to have a fee of two shillings and sixpence from the person requiring the same to be registered; and the registrar, over and above the fee hereinafter enacted in respect of every birth registered by him, shall be entitled, unless the delay shall have been occasioned by his default, to have a fee of five shillings from the person requiring the same to be registered; and no register of births shall be given in evidence to prove the birth of any child wherein it shall appear that forty-two days have intervened between the day of the birth and the day of the registration of the birth of such child, unless the entry shall be signed by the superintendent registrar; and every person who shall knowingly register or cause to be registered the birth of any child, otherwise than hereinbefore is last mentioned, after the expiration of forty-two days following the day of the birth of such child, shall forfeit and pay for every such offence a sum not exceeding fifty pounds.

XXIII. *And be it enacted*, That after the expiration of six calendar months following the birth of any child, it shall not be lawful for any registrar to register the birth of such child, and no register of births except in the case of children born at sea shall be given in evidence to prove the birth of any child wherein it shall appear that six calendar months have intervened between the day of the birth and the day of the registration of the birth of such child; and every person who shall knowingly register or cause to be registered the birth of any child after the expiration of six calendar months following the day of the birth of such child shall forfeit and pay for every such offence a sum not exceeding fifty pounds.

XXV. *And be it enacted*, That some person present at the death or in attendance during the last illness of every person dying in England after the said first day of March, or in case of the death, illness, inability, or default of all such persons, the occupier of the house or tenement, or if the occupier be the person who shall have died, some inmate of the house or tenement in which such death shall have happened, shall, within eight days next after the day of such death, give information, upon being requested so to do, to the said registrar, according to the best of his or her knowledge and belief, of the several particulars hereby required to be known and registered touching the death of such person: *Provided, always*, That in every case in which an inquest shall be held on any dead body the jury shall inquire of the particulars

herein required to be registered concerning the death, and the coroner shall inform the registrar of the finding of the jury, and the registrar shall make the entry accordingly.

XXVI. *And be it enacted*, That if any of His Majesty's English subjects snall die at sea on board of a British vessel, the captain or commanding officer of the vessel on board of which such death shall have happened shall forthwith make a minute of the several particulars hereinbefore required to be inserted in the register touching such death so far as the same may be known, and the name of the vessel wherein the death took place, and shall, on the arrival of such vessel in any port of the United Kingdom, or by any other sooner opportunity, send a certificate of the said minute through the post-office to the registrar-general, who shall file the same and enter a copy thereof under his hand in the marine register book, and keep the same with the other registers, according to the provisions of this act.

XXVII. *And be it enacted*, That every registrar, immediately upon registering any death, or as soon thereafter as he shall be required so to do, shall, without fee or reward, deliver to the undertaker or other person having charge of the funeral a certificate under his hand, according to the form of Schedule (E) to this act annexed, that such death has been duly registered, and such certificate shall be delivered by such undertaker or other person to the minister or officiating person who shall be required to bury or to perform any religious service for the burial of the dead body; and if any dead body shall be buried for which no such certificate shall have been so delivered, the person who shall bury or perform any funeral or any religious service for the burial shall forthwith give notice thereof to the registrar: *Provided, always*, That the coroner, upon holding any inquest, may order the body to be buried, if he shall think fit, before registry of the death, and shall in such case give a certificate of his order in writing under his hand, according to the form of Schedule (F) to this act annexed, to such undertaker or other person having charge of the funeral, which shall be delivered as aforesaid; and every person who shall bury or perform any funeral or any religious service for the burial of any dead body for which no certificate shall have been duly made and delivered as aforesaid, either by the registrar or coroner, and who shall not within seven days give notice thereof to the registrar, shall forfeit and pay any sum not exceeding ten pounds for every such offence.

XXVIII. *And be it enacted*, That every person by whom the information contained in any register of birth or death under this act shall have been given shall sign his name, description, and place of abode in the register, and no register of birth or death, according to this act, shall be given in evidence which shall not be signed by some person professing to be the informant, and to be such party as is herein required to give such information to the registrar.

[Schedules to which this act refers.]

SCHEDULE A.

1836.—*Births in the district of Mary-le-bone, North, in the county of Middlesex.*

No.	When born.	Name, if any.	Sex.	Name and surname of father.	Name and maiden surname of mother.	Rank or profession of father.	Signature, description, and residence of informant.	When registered.	Signature of registrar.	Baptismal name, if added after registration of birth.
	January 7 ..	James ..	Boy.	William Green..	Rebecca Green, formerly Jennings.	Carpenter ..	William Green, father, carpenter, 17 North street, Mary-le-bone.	January 9.	John Cox, registrar.	

SCHEDULE B.

1836.—*Deaths in the district of Mary-le-bone, North, in the county of Middlesex.*

No.	When died.	Name and surname.	Sex.	Age.	Rank or profession.	Cause of death.	Signature, description, and residence of informant.	When registered.	Signature of registrar.
17	February 4...	William Green.	Male..	43	Carpenter	.....	Rebecca Green, widow, 17 North street, Mary-le-bone.	February 5	John Cox, registrar.

(The words and figures in italics in this schedule to be filled in according as the case may be.)

AN ACT to explain and amend two acts passed in the last session of Parliament for marriages, and for registering births, deaths, and marriages in England.

(June 30, 1837.)

VI. And whereas it hath been doubted, under the provisions of the said act for registering births, deaths, and marriages in England, when the registration of the births and deaths of persons born and dying at sea ought to begin:

Be it enacted, That the marine register books shall begin with the birth and death, respectively, which shall happen of persons born or dying at sea after the last day of June, one thousand eight hundred and thirty-seven, and of which a certificate shall be first sent to the registrar-general, according to the provisions of the last-recited act, and shall not contain any registry of the birth or death of any person born or dying at sea before the first day of July, one thousand eight hundred and thirty-seven.

VII. *And be it enacted*, That the registrar-general may receive and send by the general post from and to all ports and places in the United Kingdom of Great Britain and Ireland all letters and packets relating exclusively to the execution of the said acts for marriages, and for registering births, deaths, and marriages, or of this act, free from the duty of postage, subject to the provisions and conditions of the said act for registering births, deaths, and marriages, with respect to letters and packets so received or sent by him from and to places in England.

VIII. *And be it enacted*, That it shall be lawful for the registrar-general, if he shall think fit, to direct that the place of birth or death of any person whose birth or death shall be registered under the said act for registering births, deaths, and marriages, shall be added to the entry in such manner as the registrar-general shall direct; and such addition, when so made, shall be taken to all intents to be part of the entry in the register.

AN ACT to amend the law relating to the registration of births and deaths in England, and to consolidate the law respecting the registration of births and deaths at sea.

(August 7, 1874.)

Registration of births.

1. In the case of every child born alive after the commencement of this act it shall be the duty of the father and mother of the child, and in default of the father and mother, of the occupier of the house in which to his knowledge the child is born, and of each person present at the birth, and of the person having charge of the child, to give to the registrar, within forty-two days next after such birth, information of the particulars required to be registered concerning such birth, and in the presence of the registrar to sign the register.

2. Where a birth has, from the default of the parents or other persons required to give information concerning it, not been duly registered, the registrar may, at any time after the end of forty-two days from such birth, by notice in writing, require any of the persons required by this act to give information concerning such birth to attend personally at the registrar's office, or at any other place appointed by the registrar within his subdistrict within such time (not less than seven days after the receipt of such notice, and not more than three months from the date of the birth) as may be specified in such notice, and to give information, to the best of such person's knowledge and belief, of the particulars required to be registered concerning such birth, and to sign the register in the presence of the registrar; and it shall be the duty of such person, unless the birth is registered before the expiration of the time specified in such requisition, to comply with such requisition.

3. In case any living new-born child is found exposed, it shall be the duty of any person finding such child, and of any person in whose charge such child may be placed, to give, to the best of his knowledge and belief, to the registrar, within seven days after the finding of such child, such information of the particulars required to be registered concerning the birth of such child as the informant possesses, and in the presence of the registrar to sign the register.

4. It shall be the duty of the registrar to inform himself carefully of every birth which happens within his subdistrict, and upon receiving personally from the informant at any time within three months from the date of the birth of any child, or the finding of any living new-born child information of the particulars required to be registered concerning the birth of such child, forthwith in the prescribed form and manner to register the birth and said particulars (if not previously registered), without fee or reward from the informant, except that if, in pursuance of a written requisition, he registers the same at the residence of the person making such requisition, or at the house in which thebirth took place, he shall, unless the birth took place in a public institution, be entitled to the appointed fee.

5. After the expiration of three months next after the birth of any child, a registrar shall not register such birth, except as in this section provided; that is to say, in case the birth of any child has not been registered in accordance with the births and deaths registration acts, 1836 to 1874, the registrar may, after three, and not later than twelve months next after the birth, by notice in writing, require any of the persons required by this act to give information concerning the birth, to attend personally at the district register office, within such time (not less than seven days after the receipt of the notice, and not more than twelve months after the date of the birth) as may be specified in the notice, and make before the superintendent registrar a solemn declaration, according to the best of declarant's knowledge and belief, of the particulars required to be registered concerning the birth, and sign the register in the presence of the registrar and superintendent registrar, whether in pursuance of a requistion or not, and making such a declaration as aforesaid, and giving information concerning the birth, the registrar shall then and there, in the presence of such superintendent registrar, register the birth according to the information of the declarant, and the superintendent registrar before whom the declaration is made shall, as well as the registrar and declarant, sign the entry of the birth.

After the expiration of twelve months next after the birth of any child, that birth shall not be registered except with the written authority of the registrar-general for registering the same, and except in accordance with the prescribed rules, and the fact of such authority having been given shall be entered in the register.

Every person who registers or causes to be registered the birth of any child in contravention of this section shall be liable to a penalty not exceeding ten pounds.

6. Any person required by this act to give information concerning a birth, who removes before such birth is registered out of the subdistrict in which such birth has taken place, may, within three months after such birth, give the information by making and signing in the presence of the registrar of the subdistrict in which he resides a declaration in writing of the particulars required to be registered concerning such birth; and such registrar on payment of the appointed fee shall receive and attest the declaration and send the same to the registrar of the subdistrict in which the birth took place; and the last-mentioned registrar shall in the prescribed manner enter the birth in the register; and the entry so made shall be deemed for the purposes of the births and deaths registration acts, 1836 to 1874, to have been signed by the person who signed the declaration.

A person making a declaration in pursuance of this section in the case of any birth shall be deemed to have complied with the provisions of this act as to giving information concerning that birth, and with any requisition of the registrar made under this act within the said three months to attend and give information concerning that birth.

7. In the case of an illegitimate child, no person shall, as father of such child, be required to give information under this act concerning the birth of such child, and the registrar shall not enter in the register the name of any person as father of such child, unless at the joint request of the mother and of the person acknowledging himself to be the father of such child, and such person shall in such case sign the register together with the mother.

8. When the birth of any child has been registered, and the name, if any, by which it was registered is altered, or if it was registered without a name, when a name is given to it, the parent or guardian of such child, or other person procuring such name to be altered, or given, may, within twelve months next after the registration of the birth, deliver to the registrar or superintendent registrar such certificate as hereinafter mentioned, and the registrar or superintendent registrar, upon the receipt of that certificate, and on payment of the appointed fee, shall, without any erasure of the original entry, forthwith enter in the register book the name mentioned in the certificate as having been given to the child, and having stated upon the certificate the fact of such entry having been made, shall forthwith send the certificate to the registrar-general, together with a certified copy of the entry of the birth with the name so added.

The certificate shall be in the form given in the first schedule to this act, or as near thereto as circumstances admit, and shall be signed by the minister or person who performed the rite of baptism upon which the name was given or altered, or, if the child is not baptised, shall be signed by the father, mother, or guardian of the child, or other person procuring the name of the child to be given or altered.

Every minister or person who performs the right of baptism shall deliver the certificate required by this section on demand on payment of a fee not exceeding one shilling.

The provisions of this section shall apply, with the prescribed modifications in the case of births at sea, of which a return is sent to the registrar-general of births and deaths in England.

Registration of deaths.

9. The death of every person dying in England after the commencement of this act, and the cause of such death, shall be registered by the registrar in the manner directed by the births and deaths registration acts, 1836 to 1874.

10. When a person dies in a house after the commencement of this act it shall be the duty of the nearest relatives of the deceased, present at the death or in attendance during the last illness of the deceased, and, in default of such relatives, of each person present at the death, and of the occupier of the house in which, to his knowledge, the death took place, and in default of the persons hereinbefore in this section mentioned of each inmate of such house, and of the person causing the body of the deceased person to be buried, to give, to the best of his knowledge and belief, to the registrar, within the five days next following the day of such death, information of the particulars required to be registered concerning such death, and in the presence of the registrar to sign the register.

11. Where a person dies in a place which is not a house, or a dead body is found elsewhere than in a house, it shall be the duty of every relative of such deceased person having knowledge of any of the particulars required to be registered concerning the death, and, in default of such relative, of every person present at the death, and of any person finding, and of any person taking charge of the body, and of the person causing the body to be buried, to give to the registrar, within the five days next after the death or the finding, such information of the particulars required to be registered concerning the death as the informant possesses, and in the presence of the registrar to sign the register.

12. If a person required to give information concerning any death sends to the registrar a written notice of the occurrence of the death, accompanied by such medical certificate of the cause of the death as is required by this act to be delivered to a registrar, the information of the particulars required by the births and deaths registration acts, 1836 to 1874, to be registered concerning the death need not be given within the said five days, but shall, notwithstanding such notice, be given within fourteen days next after the day of the death by the person giving such notice, or some other person required by this act to give the information.

13. Where any death has, from the default of the persons required to give information concerning it, not been registered the registrar may at any time after the expiration of fourteen days and within twelve months from the day of such death or from the finding of the dead body elsewhere than in a house, by notice in writing, require any person required by this act to give information concerning such death to attend personally at the registrar's office or at any other place appointed by the registrar within his subdistrict, within such time (not less than seven days after the receipt of the notice nor more than twelve months after the death or finding of the dead body) as may be specified in the notice, and to give the said information to the best of the informant's knowledge and belief, and to sign the register in the presence of the registrar; and it shall be the duty of such person, unless the death is registered before the expiration of the time specified in the requisition, to comply with the requisition.

14. It shall be the duty of the registrar to inform himself carefully of every death which happens within his subdistrict, and, upon receiving personally from the informant, at any time within twelve months after the date of any death, or of the finding of any dead body, information of the particulars required to be registered concerning the death from any person required by this act to give the same, forthwith in the prescribed form and manner to register the death and the said particulars (if not previously registered) without fee or reward from the informant, except that if, in pursuance of a written requisition, he registers the same at the residence of the person making such requisition, or at the house where the deceased died, he shall, unless the death took place in a public institution, be entitled to the appointed fee.

15. After the expiration of twelve months next after any death, or after the finding of any dead body elsewhere than in a house, that death shall not be registered, except with the written authority of the registrar-general for registering the same, and except in accordance with the prescribed rules, and the fact of such authority having been given, shall be entered in the register.

Every person who registers or causes to be registered any death in contravention of this section shall be liable to a penalty not exceeding ten pounds.

16. Where an inquest is held on any dead body the jury shall inquire of the particulars required to be registered concerning the death, and the coroner shall send to the registrar, within five days after the finding of the jury is given, a certificate, under his hand, giving information concerning the death and specifying the finding of the jury with respect to the said particulars, and to the cause of death, and specifying the time and place at which the inquest was held, and the registrar shall, in the prescribed form and manner, enter the death and particulars. If the death has been previously registered the said particulars shall be entered in the prescribed manner without any alteration of the original entry.

Where an inquest is held on any dead body no person shall, with respect to such dead body or death, be liable to attend upon a requisition of a registrar, or be subject to any penalty for failing to give information in pursuance of any other provision of this act.

BURIALS.

17. A coroner, upon holding an inquest upon any body may, if he thinks fit, by order under his hand authorize the body to be buried before registry of the death, and shall give such order to the relative of the deceased or other person who causes the body to be buried, or to the undertaker or other person having charge of the funeral; and, except upon holding an inquest, no order, warrant, or other document for the burial of any body shall be given by the coroner.

The registrar, upon registering any death, or upon receiving a written requisition to attend at a house to register a death, or upon receiving such written notice of the occurrence of a death, accompanied by a medical certificate, as is before provided by this act, shall forthwith, or as soon after as he is required, give without fee or reward, either to the person giving information concerning the death or sending the requisition or notice, or to the undertaker or other person having charge of the funeral of the deceased, a certificate under his hand that he has registered or received notice of the death, as the case may be.

Every such order of the coroner and certificate of the registrar shall be delivered to the person who buries or performs any funeral or religious service for the burial of the body of the deceased; and any person to whom such order or certificate was given by the coroner or registrar who fails so to deliver, or cause to be delivered, the same shall be liable to a penalty not exceeding forty shillings.

The person who buries or performs any funeral or religious service for the burial of any dead body as to which no order or certificate under this section is delivered to him shall, within seven days after the burial, give notice thereof in writing to the registrar, and if he fails so to do, shall be liable to a penalty not exceeding ten pounds.

18. A person shall not wilfully bury or procure to be buried the body of any deceased child as if it were still-born.

A person who has control over or ordinarily buries bodies in any burial-ground shall not permit to be buried in such burial-ground the body of any deceased child as if it were still-born, and shall not permit to be buried or bury in such burial-ground any still-born child before there is delivered to him either—

(*a.*) A written certificate that such child was not born alive, signed by a registered medical practitioner who was in attendance at the birth, or has examined the body of such child; or

(*b.*) A declaration signed by some person who would, if the child had been born alive, have been required by this act to give information concerning the birth to the effect that no registered medical practitioner was present at the birth, or that his certificate cannot be obtained, and that the child was not born alive; or

(*c.*) If there has been an inquest, an order of the coroner.

Any person who acts in contravention of this section shall be liable to a penalty not exceeding ten pounds.

Where there is in the coffin in which any deceased person is brought for burial the body of any other deceased person, or the body of any still-born child, the undertaker or other person who has charge of the funeral shall deliver to the person who buries or performs any funeral or religious service for the burial of such body or bodies notice in writing, signed by such undertaker or other person, and stating, to the best of his knowledge and belief, with respect to each such body, the following particulars:

(*a.*) If the body is the body of a deceased person, the name, sex, and place of abode of the said deceased person;

(*b.*) If the body has been found exposed, and the name and place of abode are unknown, the fact of the body having been so found, and of the said particulars being unknown; and

(*c.*) If the body is that of a deceased child without a name, or a still-born child, the name and place of abode of the father, or, if it is illegitimate, of the mother of such child.

Every person who fails to comply with this section shall be liable to a penalty not exceeding ten pounds.

CERTIFICATES OF CAUSE OF DEATH.

20. With respect to certificates of the cause of death the following provisions shall have effect:

(1.) The registrar-general shall from time to time furnish to every registrar printed forms of certificates of cause of death by registered medical practitioners, and every

registrar shall furnish such forms gratis to any registered medical practitioner residing or practicing in such registrar's subdistrict.

(2.) In case of the death of any person who has been attended during his last illness by a registered medical practitioner, that practitioner shall sign and give, to some person required by this act to give information concerning the death, a certificate stating to the best of his knowledge and belief the cause of death, and such person shall, upon giving information concerning the death, or giving notice of the death, deliver that certificate to the registrar, and the cause of death as stated in that certificate shall be entered in the register, together with the name of the certifying medical practitioner.

(3.) Where an inquest is held on the body of any deceased person, a medical certificate of the cause of death need not be given to the registrar, but the certificate of the finding of the jury furnished by the coroner shall be sufficient.

If any person to whom a medical certificate is given by a registered medical practitioner in pursuance of this section fails to deliver that certificate to the registrar, he shall be liable to a penalty not exceeding forty shillings.

27. Every superintendent registrar and registrar, respectively, shall be entitled to the fees specified in the second schedule to this act, and every such fee shall be paid to him by the persons and on the occasions pointed out in such schedule, and may be recovered as a debt due to him, and, subject to the prescribed rules, he may refuse to comply with any application voluntarily made to him until the fee is paid.

28. Every registrar, when and as required by a sanitary authority, as defined by the public health act, 1872, shall transmit, by post or otherwise, a return, certified under the hand of such registrar to be a true return, of such of the particulars registered by him concerning any death as may be specified in the requisition of the sanitary authority.

The sanitary authority may supply a form of the prescribed character for the purpose of the return, and in that case the return shall be made in the form so supplied.

The registrar making such return shall be entitled to a fee of two pence, and to a further fee of two pence for every death entered in such return, which fee shall be paid by the authority requiring the return.

31. The payment to the registrar, under section twenty-nine of the principal act, of two shillings and sixpence for each of the first twenty entries of births and deaths in every year which he has registered shall be paid to him for each of the first twenty entries of births and deaths in each quarterly account made out and verified in manner directed by that act.

35. Every registrar who refuses or without reasonable cause omits to register any birth or death, or particulars concerning which information has been tendered to him by an informant, and which he ought to register, and every person having the custody of any register book of births and deaths who carelessly loses or injures or allows the injury of the same shall be liable to a penalty not exceeding fifty pounds.

39. Every person required by the births and deaths registration acts, 1836 to 1874, to give any information concerning any birth or death, or any living new-born child, or any dead body, who wilfully refuses to answer any question put to him by the registrar relating to the particulars required to be registered concerning such birth or death, or fails to comply with any requisition of the registrar made in pursuance of those acts, and every person who refuses or fails, without reasonable excuse, to give or send any certificate in accordance with the provisions of the said acts shall be liable to a penalty not exceeding forty shillings for each offence; and the parent of any child who fails to give information concerning the birth of such child, as required by the said acts, shall be liable to a like penalty; and a person required by the said acts to give information concerning a death in the first instance, and not merely in default of some other person, shall, if such information as is required by the said acts is not duly given, be liable to the same penalty.

40. Any person who commits any of the following offences; that is to say—

(1) Wilfully makes any false answer to any question put to him by a registrar relating to the particulars required to be registered concerning any birth or death, or wilfully gives to a registrar any false information concerning any birth or death, or the cause of any death; or,

(2) Wilfully makes any false certificate or declaration under or for the purposes of this act, or forges or falsifies any such certificate or declaration, or any order under this act, or, knowing any such certificate, declaration, or order to be false or forged, uses the same as true, or gives or sends the same as true, to any person; or

(3) Wilfully makes, gives, or uses any false statement or representation as to a child born alive having been still-born, or as to the body of a deceased person or a still-born child in any coffin, or falsely pretends that any child born alive was still-born; or,

(4) Makes any false statement with intent to have the same entered in any register of births or deaths; shall for each offence be liable on summary conviction to a penalty not exceeding ten pounds, and on conviction on indictment to fine or imprison-

ment with or without hard labour for a term not exceeding two years, or to penal servitude for a term not exceeding seven years.

44. It shall be lawful for the local government board or the registrar-general, with the consent of the local government board by order, to alter from time to time all or any of the forms contained in the schedule to the principal act and this act, or in any order under this section, in such manner as may appear to them best for carrying into effect the births and deaths registration acts, 1836 to 1874, or to prescribe new forms for that purpose, and from time to time to make regulations for prescribing any matters authorized by this act to be prescribed, and to revoke and alter such regulations.

Any order made in pursuance of this section shall be published in the London Gazette, and shall be laid before both Houses of Parliament, if Parliament is sitting, within fourteen days after the issue of the same, or if Parliament is not then sitting, within fourteen days after the commencement of the then next session.

Every form when altered in pursuance of this section shall have the same effect as if it had been contained in a schedule to the principal act or this act, as the case may be, and every regulation made in pursuance of this section shall, while in force, have the same effect as if it were enacted in this act.

Fees to registrars and superintendent registrars.

For registering a birth or death when required to do so at residence of person signing requisition, or at house where child born or person died (not being a public institution), to registrar one shilling, to be paid by the informant.

Upon the registration of a birth when the child is more than three months old, if it is not more than twelve months old, to superintendent registrar two shillings and sixpence, and to the registrar (unless the delay is occasioned by his failure to issue a requisition, or otherwise by his default) two shillings and sixpence, and if it is more than twelve months old, and is registered with the authority of the registrar-general, to superintendent registrar five shillings, and to registrar (unless the delay is occasioned by his failure to issue a requisition or otherwise by his default) five shillings, to be paid by the informant or declarant.

Upon the registration of a death with the authority of the registrar-general after the expiration of twelve months, to the superintendent registrar five shillings, and to the registrar (unless the delay is occasioned by his failure to issue a requisition or otherwise by his default) five shillings, to be paid by the informant or declarant.

For taking, attesting, and transmitting a declaration made by an informant respecting a birth in another subdistrict, to the registrar attesting the declaration two shillings, to be paid by the informant.

For entering the baptismal or other name of child upon certificate produced after registry of birth, to superintendent registrar or registrar one shilling, to be paid by the person procuring the name to be entered.

Correction of error of fact in register, to superintendent registrar or registrar two shillings and sixpence, to be paid by the person requiring the error to be corrected.

For every search, to the superintendent registrar, to be paid by the applicant for the search, if it is a general search, five shillings, if it is a particular search, one shilling.

For a certified copy of any entry given by the superintendent registrar, two shillings and sixpence to the superintendent registrar, to be paid by the applicant.

APPENDIX F.

CORRESPONDENCE WITH HIS EXCELLENCY, GOVERNOR McENERY, OF LOUISIANA.

1. **LETTER OF DR. JAMES L. CABELL, PRESIDENT NATIONAL BOARD OF HEALTH, TO GOVERNOR McENERY.**
2. **RESPONSE OF GOVERNOR McENERY.**

NATIONAL BOARD OF HEALTH,
May 29, 1882.

SIR: I respectfully invite your attention to the inclosed extract from the minutes of the executive committee of the National Board of Health.

In executing the order of the committee, I take occasion to say, that the act of Congress creating this Board, approved March 3, 1879, a copy of which is herewith inclosed, prescribes, among other duties, that of advising the executives of the several States whenever, in the opinion of the Board, such advice may tend to the preservation and improvement of the public health.

Convinced that the measure now again recommended is of vital importance to the preservation of the public health, this Board cannot divest itself of the obligation, imposed by the provisions of the act of Congress just referred to, to renew a recommendation which has heretofore been made to your predecessor and to the State board of health.

The policy of excluding actually infected vessels from the local quarantine stations and sending them to isolated places of refuge furnished by the National Board of Health has been recommended to and eagerly adopted by the health authorities of every port on the South Atlantic and Gulf coast east of New Orleans, except Key West. They consider its adoption essential to the safety of the public health, and they testify that it in no degree interferes with their authority or abridges the revenue from the sanitary inspection of vessels at their proper quarantine stations.

It is believed that yellow fever has not unfrequently been propagated at local quarantines by the proximity of infected vessels to others not previously infected but held under observation for a limited time under local quarantine regulations.

Apart from the prospective advantages likely to result in the protection of the public health, I would further say that the adoption of this policy would, in my opinion, at once dispel the distrust and fears of the health authorities of the Mississippi Valley States, and exert a most happy influence by averting the frequently threatened infliction of quarantine restrictions on the commerce of New Orleans.

Very respectfully, your obedient servant,

J. L. CABELL,
President National Board of Health.

His Excellency S. D. MCENERY,
Governor of Louisiana, Baton Rouge, La.

EXECUTIVE DEPARTMENT,
STATE OF LOUISIANA,
Baton Rouge, June 5, 1882.

SIR: Your favor of the 29th May received, and I have referred it to the general assembly for such legislation as it may deem necessary.

Yours, respectfully,

S. D. MCENERY,
Governor.

Dr. J. L. CABELL,
President National Board of Health, Washington, D. C.

APPENDIX G.

REPORT OF OPERATIONS AT SHIP ISLAND REFUGE STATION.

DR. T. S. SCALES, *Superintendent.*

QUARANTINE STATION,
Ship Island, October 21, 1882.

DEAR SIR: In accordance with your request for my final report about this date, I have the honor to submit as follows:

ARRIVAL OF VESSELS.

Inclosed herewith is a complete tabulated list of all the vessels boarded in Ship Island harbor from commencement of this season's quarantine, May 1 to October 10, and as nothing of sanitary interest transpired in connection with those indicated as not having been quarantined they will be passed by, and a brief history attempted of those that were subjected to quarantine, as follows:

American schooner H. Buddey arrived at this station on the 26th of May from Tampico, Mexico, with captain and mate quite sick with a low type of malarial fever, as reported at the time to the office of the secretary, and in order to give these people the medical attention required for their recovery they were admitted into the hospital, and after their recovery the vessel was fumigated and discharged from quarantine on the 5th of June.

British bark Veritas arrived from Rio de Janeiro, without sickness, on the 9th of June, and, after fumigation, was discharged on the 12th of the same month.

Norwegian bark Jebra, from Havana, was sent to this station from Pensacola in consequence of a suspicious case of fever on board arriving here June 20. This patient was admitted into the hospital and recovered, after which the vessel was subjected to fumigation and returned to Pensacola without subsequent sickness, so far as I ever heard. The patient referred to was not thought by me to have had a case of yellow fever, and this opinion was expressed to the honorable secretary of the National Board of Health.

Welsh bark Magnolia, from Aspinwall, arrived on the 29th of June, and, after fumigation, was discharged on the 11th of July with no evidence of the existence of infectious disease on board at any time.

Russian bark Iris arrived on the 30th of June from Havana, having been dispatched here from Pensacola in consequence of the first mate being sick on board with yellow fever. This man died off Fort Morgan on the evening of the 29th of June and was buried at sea; therefore, at the time of the vessel's arrival here there was no case of sickness on board. Boarding the vessel soon after arrival I learned the above facts from the captain, and also that he was the only one of the remaining fourteen on board that ever had yellow fever, though the captain stated that he did not think there would be another case, as all the bedding and wearing apparel of the dead mate were thrown into the sea soon after death, and that no one but himself had attended the man during sickness. I informed the captain that with so much unacclimated material on board I could scarcely venture to hope an escape from future trouble, but would give his people the benefit of any doubt of exposure, if a doubt existed, and would fumigate the vessel the following day, which was accordingly done on the 1st of July. On the 5th of July, a sailor from this vessel, with yellow fever, was admitted into hospital, recovered, was given a tepid bath and clean clothing, and returned to the vessel on the 15th of July, on which day the vessel was subjected to a second fumigation, and as there had been no sickness on the vessel from the 5th to the 15th, when the sick man was sent to the hospital, and there had been positively no

communication between the sick man in hospital and the well on board the vessel from the 5th to the 15th, and no sickness on board on the 16th, the vessel was discharged from quarantine that day to report to the quarantine physician at Pensacola with a letter from myself recounting what had been done here, and stating simply that the vessel "*should* now be in good condition." This vessel arrived at Pensacola quarantine station about the 18th of July, and as soon as the anchor was let go the second mate went to bed with yellow fever, and then two or three others in rapid succession, one dying there and being buried on Santa Rosa Island. In consequence of this condition of affairs the vessel was returned to this station, arriving about midnight of the 22d July. Boarding her early the next morning the second mate was discovered in a dying condition, and a short time after death was interred in the station cemetery; two others sick were received in the hospital. During the last visit of this vessel there were eight patients treated in the hospital, making a total of nine, with two deaths. The captain had suffered with the disease some years ago. There was one man aboard that the captain stated had been attacked mildly, and still another that escaped the disease altogether. To sum up, we find that of the entire crew of fifteen there were thirteen attacked, with five deaths, as follows: First mate, at sea, off Fort Morgan; second mate, on board soon after arrival here the second and last time; a seaman at Pensacola quarantine station, and buried on Santa Rosa Island, and two seamen in hospital here. As above stated, this vessel only returned to Pensacola quarantine station from this station a second time, and not a third time, as stated in the daily press. The details of the process of fumigation and disinfection otherwise as practiced on this vessel during her detention at this station are omitted here, as the same have already been submitted through the medium of my weekly and special quarantine reports on the subject, which I ask to be submitted as part of this report.

American schooner Eliza Ann arrived from Tampico on July 3 with almost the entire crew suffering from effects of malarial fever, having one death during the voyage from the same cause, and after fumigation was discharged from quarantine July 15, with crew well or materially improved. This vessel arrived again from the same port on the 3d of September, without sickness, and after fumigation was discharged on the 13th of September.

American steamer James A. Gary arrived on the 8th of July from Havana, sent here, the captain stated, by the Apalachicola health authorities, and after ten days' detention, and fumigation, without sickness, was discharged on the 18th of July.

Spanish bark Rosa y Carmen, from Havana, arrived in ballast on the 13th of July, and after ten days' detention, without sickness, was subjected to fumigation and discharged on the 23d July. This vessel arrived again on the 21st September under similar circumstances, and after similar treatment was discharged on October 1.

British bark Windward, from Aspinwall, arrived on July 18 with one of the crew quite sick with Chagres fever, recovery at the time being considered very doubtful, and so reported to the secretary of the board. In order to give this man every chance for his life, he was admitted into hospital and finally recovered, and was returned to his vessel, which was fumigated and discharged from quarantine on 30th July. This vessel also lost a man during the voyage from Aspinwall, whose death I attribute to Chagres fever.

Austrian bark Urano, from Havana, arrived on the 22d July, having been ordered to this station by the Mobile quarantine authorities in consequence of a telegram from Dr. Burgess to the National Board, stating that when the vessel sailed from Havana on July 2, she sent a man to hospital there, sick with yellow fever, which man died on July 4. This vessel also lost a man at sea on July 13; cause evidently yellow fever. After sufficient quarantine detention, observation, and treatment at this station, the vessel was discharged on August 21, and as the captain in chartering for Mobile reserved the right to break the charter in case the vessel was ordered to the Ship Island station, he declined returning to Mobile, and took on a cargo of lumber at this port, and put to sea without further sickness that I ever heard of.

American schooner White Sea, from Havana, arrived without sickness on 31st July, and after fumigation was discharged on August 11.

American schooners Yosemite and Gustie Wilson, from Tampico, arrived, the former on August 4, and the latter on August 7, both without sickness, and after fumigation were discharged on the 11th and 15th of August, respectively. A Malay cook, however, on board the Gustie Wilson, dropped dead with heart disease while this vessel was under observation here.

American schooner Henrietta, from Brazos Santiago, arrived on August 10, having been dispatched to this station as an infected vessel by the Galveston board of health. She had a large number of passengers, considering her accommodation capacity, which passengers comprised Stutt's Mammoth Star Company (theatrical), and it was in consequence of a death of a member of this company, and the sickness of another, that the vessel was sent here. These passengers were kept under observation at the Lazaretto until the 25th of August, and after fumigation of all their effects, and no

other sickness occurring, were discharged from quarantine, and went into the interior of Louisiana by way of New Orleans. The schooner was also detained until the 25th of August, and, no sickness occurring in the crew, was subjected to fumigation and discharged. If this vessel really was infected with yellow fever the passengers and crew certainly had a miraculous escape from its attack, as there was among them an abundance of unacclimated material.

Spanish brigantine Francisco arrived on August 16, having been sent from Pensacola in consequence of the death of a member of her crew while discharging ballast. After fumigation this vessel was discharged from quarantine on the 30th August, taking on a cargo of lumber thereafter at Pearlington, Miss., without subsequent sickness, so far as I can ascertain. This vessel sailed from Matanzas about the 14th of July and arrived at the Pensacola quarantine station about the 23d July, and as subsequent developments on board said vessel may shed some light in an investigation as to the origin of yellow fever in Pensacola this summer, I will again allude to her before concluding this report.

Norwegian ship Freydis, having lost two men at Aspinwall and three during the voyage thence to Pensacola, was met on her approach to Pensacola harbor by a pilot who ordered her to this station, where she arrived on the 22d of August with the captain and four others of the crew quite sick with Chagres fever. In order to do these sick people full justice in the way of medical treatment, they were transferred to the hospital, which had been previously thoroughly fumigated; but in consequence of the arrival, two or three days thereafter, of two vessels with yellow fever on board, they were removed to the Lazaretto for treatment, and finally returned to the ship, which, having been already fumigated, was discharged from quarantine on September 25.

Italian bark Rosa B., sent from Pensacola, arrived on the 26th of August with mate, boatswain, and cook sick with yellow fever, and in a short while the entire crew of thirteen succumbed to the disease with five deaths. This vessel having a cargo of lumber, was fumigated as well as was possible under the circumstances.

Italian bark Vincenzo Accame, sent from Pensacola, arrived on August 27 with one body dead of yellow fever, one man in a dying condition, and still another very sick, and, a short while after arrival, the mate, just appointed to take charge of the vessel prior to her leaving Pensacola for this station, was attacked and died, as well as the man just alluded to as being very sick at time of vessel's arrival, so that there were four deaths in the crew of this vessel after leaving Pensacola, and I am informed that the captain and mate died with yellow fever before the vessel left Pensacola. I attribute the heavy mortality to the fact that the officers in charge of these vessels would not promptly send their sick to the hospital, not coming themselves until almost in a dying condition; and the further fact that it was almost an impossibility to have them follow directions as to remaining in bed, &c. The Vincenzo Accame being also loaded with lumber, the same remarks made in relation to the fumigation of the Rosa B. will apply to her also; and notwithstanding no case of sickness has appeared on either of these vessels for one month, they still remain here awaiting action of interested parties to order them to sea.

Norwegian bark Agnes Campbell, from Vera Cruz, arrived on August 28, without sickness, and after fumigation was discharged on September 7.

American schooner J. A. Hatry, from Corpus Christi, arrived on 3d September, and after fumigation was discharged on September 12. This vessel was subjected to observation on account of prevalence of yellow fever on the Texas coast adjacent to her port of departure.

American schooner Susan Scranton, from Havana, arrived on 24th of September, and after fumigation was discharged on October 4.

American steamer Sylvan Dell, from Pensacola, made her way through Grant's Pass, and along the Mississippi Sound to the back Bay of Biloxi, where she was detected by the Harrison County board of health, and ordered to this station, arriving on the 25th of September, and during her detention here a well marked case of yellow ever developed in the person of the negro fireman, who entirely recovered. The vessel after thorough fumigation was discharged from quarantine on October 13.

Mexican brig Virginia, from Frontera, Mexico, arrived on September 28, without sickness, and after fumigation was discharged on October 8. Of all the vessels treated at this station up to the present time, the Russian bark Iris is the only one on which yellow fever has again made its appearance after release from this station, and all the circumstances of interest in connection with this case that are known to me have already been communicated to your office, and now the question has been suggested as to whether or not this vessel is the cause of the

ORIGIN OF YELLOW FEVER IN PENSACOLA.

The president of the Louisana State board of health, at a meeting of that body, has stated that "the bark Iris, sent from Pensacola, Fla., to Ship Island, was returned

to Pensacola after a detention at the quarantine station of the National Board of Health, and after reaching there yellow fever again appeared on the vessel. The question as to whether the Ship Island quarantine communicated yellow fever to Pensacola must be determined when all the facts shall have been known. It is a question that should be investigated by the authorities at Washington." While agreeing with Dr. Joseph Jones that "it is a question that should be investigated," &c., I must contradict his statement that the Iris "was returned to Pensacola, and after reaching there yellow fever again appeared on the vessel," as this vessel only went to the Pensacola quarantine station, as already stated in this report. I could suggest with the same animus, perhaps, which prompted the suggestion of Dr. Jones, that inasmuch as yellow fever existed in New Orleans for a considerable interval of time, but to a *very* limited extent, and there was free and unrestricted intercourse between New Orleans and Pensacola, the question as to whether New Orleans communicated yellow fever to Pensacola must be determined when all the facts shall have been known, &c. In order to discover what communication, if any, took place between the Iris and other vessels during the brief time that the Iris was at the Pensacola quarantine station after her first release from this station, certain queries were submitted to Capt. John Eskelin, of the Iris, and the following answers were received:

"1st. After my arrival here on the 18th of July from your station, there was not any kind of communication whatever between my vessel and the Spanish bark Saleta.

"2d. As far as I can remember and judge, the distance between Iris and Saleta was about three-quarters of a mile, perhaps more.

"3d. During my stay at the quarantine here (Pensacola) we had no communication with any vessel or vessels, and the nearest vessel to the Iris (about 400 yards) was the Russian bark Osmo, which is still here, and has been without the fever on board.

"4th. The Iris was anchored about 1¼ mile from the ballast crib."

Thus we find that after the Iris appeared at the Pensacola quarantine station there was no communication whatever with other vessels, nor did she visit the ballast crib, or discharge one pound of ballast, and on the night of July 22, or morning of the 23d, she was again anchored in Ship Island quarantine.

Dr. R. B. S. Hargis, president Pensacola board of health, informs us that the origin of the yellow fever in his city is due to the Italian bark Vincenzo Accame, and that this vessel contracted the infection from the Spanish bark Saleta; but how came the Saleta infected? Dr. P. S. Carrington, quarantine physician at Pensacola, tells us that the bark Saleta, from Matanzas, arrived at his station on the 2d of July; that "owing to the crib being occupied the discharge of ballast was not completed until the 20th of July, 45 tons being retained on board. On the 21st the vessel was subjected to a process of disinfection, and on the 22d of July, an inspection of crew showing that all on board were in good health, a release from quarantine was granted and the vessel permitted to proceed to Pensacola." The night of that very day the Iris was anchored in front of my office at Ship Island, and from all the information gathered it appears that the mate of the Saleta, who was the first one attacked on that vessel, sickened with yellow fever about the 5th of August, and died on the 10th; therefore if this man's attack *could* be attributed to the Iris there must have been a period of incubation extending to at least fourteen days; but the captain of the Iris assures me that there was no communication whatever between the Saleta and the Iris, and in addition that the Russian bark Osmo, with an abundance of unacclimated material, was nearer the Iris than any other vessel, and yet escaped the disease. Let us, however, pursue the investigation a little further, and we will find that the Spanish brigantine Francisco, already alluded to in this report in this same connection, from Matanzas—the same port as the Saleta—arrived at the Pensacola quarantine station about the 23d of July, when the Saleta was at the wharf in Pensacola and the Iris was in quarantine here, so that the Francisco could not have been exposed to the Saleta or Iris, and yet while discharging ballast at the crib loses a man with what was given to the press as yellow fever, and the vessel was at once towed to this station for treatment and did not return to Pensacola. I respectfully submit that when "the question as to whether the Ship Island quarantine communicated yellow fever to Pensacola" is undergoing investigation some attention be paid to an investigation of the nature of the ballast from the Saleta, and of what became of the "45 tons retained on board" at the Pensacola quarantine station; also that some attention be paid to an investigation of the cause of death on board the Francisco while discharging ballast from the same port, Matanzas, as the Saleta, though exposed to neither the Saleta nor the Iris. In calling attention to this matter I do so without intending any reflection on the management of the Pensacola quarantine station, but simply as a matter of sanitary interest, believing as I do that just as yellow fever appeared on board the Plymouth, the Iris, the Marco Aurelio, and the Saleta, after being subjected to fumigation, just so will cases such as these happen from time to time, until our knowledge of the nature of the yellow-fever poison is more extended, and our appliances for the purification of infected

vessels more complete and satisfactory. A charge has been made, and from a quarter that can be guessed by almost any one, that Ship Island station is not a success, &c., but there appears to be a different opinion entertained by experienced sanitary officials who are most immediately concerned in the management of this station, as proven by the resolutions and communications herewith submitted as part and parcel of this report, and the fact that notwithstanding cases of yellow fever have been under treatment in hospital here almost constantly from July 5 to October 1, no case has occurred on the Mississippi coast, or elsewhere than on the vessels conveying the infection to this station.

INTERCOURSE WITH THE MAIN SHORE—HOW MAINTAINED.

During the entire season intercourse has been effected with mainland at Biloxi, and since the arrival of the first infected vessel, in the following manner: The sloop Annie was retained at Biloxi, and the steamer Day Dream at this anchorage, and on Tuesdays, Thursdays, and Sundays the steamer ran to a point opposite Biloxi, and just off the outer bar, from whence a yawl was sent and anchored in the sound, the crew of the steamer leaving the same; after which the crew of the Annie pulled out in another yawl to this anchored yawl, and made transfers of mails, &c. The crew of the steamer then went out and brought in the anchored yawl, so that the crews of these two vessels were not at any time brought in contact. On Mondays, Wednesdays, and Fridays, the sloop, weather permitting, ran over to the island, avoiding all vessels in quarantine, as well as the steamer Day Dream, and transfers were made as just described, with the exception that an open flat anchored about 400 yards in front of the physician's residence was substituted for the anchored yawl, and was used for no other purpose.

FEES COLLECTED FOR MATERIAL USED IN FUMIGATION.

The accompanying tabular statement, referred to in the first part of this report, shows that during the quarantine season $176.25 were collected for material consumed in the disinfection of vessels, and shows also how much was collected from each vessel. The entire amount has been forwarded, by express, to Dr. S. M. Bemiss, resident member of the board at New Orleans, with the request that he deposit it with the Assistant Treasurer of the United States in New Orleans, and forward to me his receipts in duplicate, the original of which will, when received, be at once transmitted to your office.

CONDITION OF THE PUBLIC PROPERTY.

Since last year's report, with the exception of the construction of a cemetery inclosure, nothing of consequence has been accomplished in the way of permanent improvements, but, exclusive of the wear and tear of property incident to its constant use, that in my charge has received proper attention.

While thanking the honorable Board of Health for the constant and cordial indorsement and support bestowed upon the management of this station, I would ask, in conclusion, that some allowance be made for the imperfection of this report, as it has been prepared, or rather hastily written, in the midst of arduous labors.

I have the honor to remain, most respectfully,

T. S. SCALES, M. D.,
Superintendent.

Dr. CH. SMART, U. S. A.,
Secretary National Board of Health, Washington, D. C.

MISSISSIPPI CITY, *September* 16, 1882.

DEAR SIR: In obedience to a resolution of the board of health for Harrison County, I inclose a copy of a resolution passed this day.

Respectfully,

F. S. HEWES, *Secretary.*

Dr. T. S. SCALES,
Superintendent, Ship Island.

Resolved, That the board of health for Harrison County, Mississippi, in answer to the published statements of Dr. Jones, president of the State board of health of Louisiana, declare that, in their opinion, the quarantine established at Ship Island, by the

National Board of Health, is a perfect success, as proven by the fact that there has not been a single case of infection arising from communication therewith; that this board has implicit confidence in the measures taken by Dr. Scales, the superintendent of the station, appointed by the National Board, and also the recognized quarantine officer of this county, and who is acting under the authority conferred by this board, for the prevention of communication with the hospital and vessels in quarantine, and they do not believe that there has been communication by pilots or others with the hospital or infected ships. In one case, which is yet under investigation, a pilot was charged with communicating with the yawl-boat of a vessel from Aspinwall, upon which there had been a case of Chagres fever. This violation was promptly reported by Dr. Scales, and legal measures will be taken for the punishment of the offender, if guilty; further, that in the opinion of this board, there being no communication allowed between the hospital, lazaretto, or quarantine anchorage, with the shipping six miles therefrom; there is no danger of infection, and no cargoes or ballast being discharged on the mainland from the vessels arriving from foreign ports, no danger therefrom is incurred. In short, in the opinion of this board, all proper and reasonable precautions have been and are taken by the health officers for the prevention of infection arising from cases at Ship Island quarantine, which opinion is supported by the fact that as yet not a single case has occurred, and that the mode adopted for the absolutely necessary communication to obtain supplies for the sick is as perfect as can well be adopted.

A true copy from the minutes of the board of health for Harrison County, held September 16, 1882.

F. S. HEWES,
Secretary Board of Health for Harrison County, Mississippi.

BAY SAINT LOUIS,
Hancock County, Mississippi, October 17, 1882.

DEAR DOCTOR: Your favor of the 12th instant is just received, and in reply, without any hesitation, will state that in the management and sanitary precautions executed by you at Ship Island during the past summer, our coast and this county have received material assistance in preventing the spread of yellow fever.

Yours, most respectfully,

E. LATHAM, M. D.,
President Board of Health.

T. S. SCALES, M. D.,
Superintendent National Quarantine Station, Ship Island, Mississippi.

OFFICE OF JACKSON COUNTY BOARD OF HEALTH,
Moss Point, Miss., October 17, 1882.

DEAR DOCTOR: Your letter of the 12th received on the 15th. In answer to your request for my written opinion as to any benefits that may have occurred to this county, in a sanitary point of view, from the management of the national quarantine station at Ship Island, I take great pleasure in replying fully and frankly.

It is impossible to enumerate or estimate all the benefits, and I shall not attempt to do so. The conception of such a station was wise, and the establishment of it eminently proper and beneficial, not only in this county but to all country bordering on the north shore of the Gulf of Mexico.

In 1874 and '75 yellow fever was introduced into this county through the port of Pascagoula for the want of adequate means and the proper appliances to prevent it. Since the establishment of your station, whenever danger from infected vessels has threatened, we have been enabled to send them to Ship Island, where the sick can be well cared for and quarantine be made almost absolute.

In addition to this, half the shipping business of this county is in vessels lying in that harbor, and your quarantine there has been as much protection to us as quarantine in our own port, as we have daily communication with it. The establishment of that station has inspired a feeling of confidence and security all along the coast that improve trade and commerce.

The management of the station, I think, has been wise, judicious, discreet, and nothing has been done that any local or State authorities could properly take exceptions to. Our thinking people regret very much that Congress failed to make the necessary appropriation at its last session to continue it in operation as long as needed, for we feel that it has been a great benefit to us.

Most respectfully,

E. F. GRIFFIN,
President Board of Health, Jackson County, Mississippi.

Dr. T. S. SCALES,
Superintendent Quarantine Station, Ship Island, Mississippi.

Report of quarantine inspections and operations at the port of Ship Island from May 1 to October 10, 1882.

No.	Name of vessel.	Description.						Name of commander.	Where from.	Days of passage.	Date of arrival.	No. of crew.	No. of passengers.	Cargo.	Bill of health.	Sanitary condition of vessel.	Disposition of vessel and remarks.		
		Steamers.	Ships.	Barks.	Brigs.	Brigantines.	Schooners.										Quarantined.		Fumigation fees charged.
																	Yes.	No.	
1	Bradsdorff			1				Stoland	Buenos Ayres	79	May 5	12	0	In ballast, sand	None.	Fair		1	
2	Elios			1				Zar	Southwest Pass	1	May 5	12	0	In ballast, stone	do	do		1	
3	Dora		1					Rodoslovitz	do	1	May 8	17	0	do	do	Good		1	
4	Fredudes			1				Pedersen	Saint Thomas	19	May 8	10	0	do	Clean	do		1	
5	Martin Luther			1				Arnsen	Amsterdam	62	May 15	15	2	In ballast, sand	do	do		1	
6	Lincoln			1				Gerolimich	Havre	53	May 15	15	3	In ballast, stone	None.	do		1	
7	Tinten			1				Olsen	Moss	63	May 19	13	0	In ballast, rubbish	do	do		1	
8	Blanche			1				Fleming	Vera Cruz	10	May 23	14	0	In ballast, sand	Clean	do		1	
9	H. Buddig						1	Lee	Tampico	13	May 25	6	1	Empty	do		1		$4 00
10	Orient		1					Allen	New Orleans	2	May 27	11	0	In ballast, copper dross	None.	Fair		1	
11	Rosita			1				Kolbery	Saint Thomas	14	June 4	10	0	In ballast, stone	Clean	do		1	
12	Pauline David		1					Otto	Havre		June 8	19	0	In ballast, sand	None.	Good		1	
13	Veritas			1				Swatridge	Rio de Janeiro	36	June 9	17	2	In ballast, stone	Foul		1		4 00
14	Wm. L. Burroughs						1	Cruby	Aransas Pass	16	June 10	10	0	In ballast, sand	None.	Good.		1	
15	Gustie Wilson						1	Gould	Tampico	10	June 12	7	0	Empty	Clean	Fair		1	
16	Cyprus			1				Parker	New Orleans	2	June 15	16	8	In ballast, sand	do	Good.		1	
17	Yosemite						1	Russell	Tampico	16	June 17	6	2	Empty	do	Fair		1	
18	Jebra			1				Noass	Pensacola	2	June 20	12	0	In ballast, stone	None.		1		7 00
19	Kertewair			1				Datema	Schiedam	48	June 25	16	0	In ballast, sand	do	Fair		1	
20	Magnolia			1				Gerrior	Aspinwall	21	June 29	10	0	In ballast, stone	Clean	do	1		4 00
21	Iris			1				Eskelin	Pensacola	2	June 30	14	0	do	Foul		1		12 00
22	Eliza Ann						1	Heurahen	Tampico	9	July 3	6	0	Empty	Clean		1		3 50
23	Jas. A. Gary	1						Norman	Havana	7	July 8	11	2	do	None	Fair	1		7 70
24	Rosa y' Carmen			1				Bilbao	do	17	July 12	8	0	In ballast, sand	Foul	do	1		6 80
25	Windward			1				Bogart	Aspinwall	16	July 18	11	0	In ballast, stone	Clean		1		8 50
26	Urano			1				Harasich	Havana	19	July 21	9	0	In ballast, sand	Foul	Bad	1		13 75
27	Aurora								New Orleans		July 22							1	
28	Iris			1				Eskelin	Pensacola	2	July 23	13	0	In ballast, stone		Bad	1		11 15
29	J. A. Hatry						1	Stiephen	Corpus Christi	7	July 24	6	0	Empty	Clean	Good		1	
30	White Sea						1	Büyge	Havana	8	July 31	7	0	do	Foul	Fair	1		5 35
31	Yosemite						1	Russell	Tampico	10	Aug 4	7	2	do	Clean	do	1		5 45
32	Alice C. Noyes						1	Nickerson	Port of Spain	18	Aug. 6	7	1	do	do	do		1	
33	Gustie Wilson						1	Gould	Tampico	9	Aug. 7	8	0	do	do	do	1		5 45
34	Henrietta						1	Tyler	Brazos Santiago.		Aug. 10	5	23		do	Bad	1		6 00
35	Francisco					1		Friuy	Pensacola	2	Aug. 16	9	0	In ballast, 10 tons sand		do	1		9 10
36	Treydis		1					Ivensen	Aspinwall	38	Aug. 20	12	0	In ballast, stone	Clean	do	1		6 10
37	Rosa B			1				Stayno	Pensacola	1	Aug. 26	13	0	Lumber	None.	do	1		9 80

38	Vincenzo Accame			1					do	1	Aug. 27	12	0	do	do	do	1		8 80
39	Agnes Campbell			1				Nielson	Vera Cruz	13	Aug. 28	13	1	In ballast, sand	Clean	Fair	1		6 10
40	Guldreyn			1				Voiyt	Barrow	68	Sept. 3	15	0	In ballast, coals	do	Good		1	
41	J. A. Hatry						1	Stiephen	Corpus Christi	7	Sept. 3	6	0	Empty	do	do	1		4 10
42	Eliza Ann						1	Heurahen	Tampico	9	Sept. 3	6	0	do	do	do	1		4 10
43	President Mabin			1				Cluzand	Bordeaux	40	Sept. 15	16	0	In ballast, stone	do	Fair		1	
44	Susan Scranton						1	Schrewer	Havana	8	Sept. 24	7	1	In ballast, water	Foul	do	1		6 40
45	Sylvan Dell	1						Felcher	Pensacola		Sept. 25	5	0	Empty	None		1		3 60
46	Virginia				1			Noweyaurd	Frontera	27	Sept. 28	8	0	In ballast, sand	Clean	Fair	1		6 10
47	John Watt			1				Sweetzer	New Orleans	1	Sept. 18	4	0	In ballast, gravel	None	do		1	
48	Rosa y' Carmen			1				Bilbao	Havana	9	Sept. 20	10	0	In ballast, sand	Foul	do	1		7 40
	Total	2	4	25	1	2	14						48				26	22	176 25

APPENDIX H.

REPORT OF OPERATIONS AT SAPELO SOUND, REFUGE STATION, BLACKBEARD ISLAND, GEORGIA.

By Dr. W. H. Elliott, *Inspector in Charge.*

Season of 1882.

The operations for this season were initiated February 22 by instructions from the National Board of Health to your inspector to visit New York for the purchase of boats and other articles of equipment needed at the station. Four boats, from 15 to 25 feet in length, were contracted for and their construction supervised. The other articles purchased were clocks, lanterns, and steam-gauges for the Gypsy, and iron buckets and bellows for fumigation of and pumps for the cleaning of vessels.

Instructions in regard to opening the station were received March 28. The work of procuring supplies in New York was completed April 15, and departure made for Savannah. Upon arrival the work of preparation was actively entered upon. An important part of this was the alteration and improvement of the Gypsy. The iron rudder, propeller, shaft, and other portions of the motive power exposed to the corrosive action of salt water, intensified by the composition sheathing on the steamer, were replaced by composition metal or phosphor bronze. The guards added the year before were closed in below by sponsons, and a new smoke-stack erected. A Knowles steam-pump was connected with the boiler for the double purpose of independent supply and delivering a stream of water aboard a vessel. These improvements, with the addition of the outfit purchased in New York, have increased the speed, safety, and comfort of the steamer, and, it is believed, have placed her in as good condition as a boat of her character is capable of.

Rations and other necessary supplies for the station having been purchased, and the employés engaged, I left Savannah May 22, and opened the station two days later, announcement to that effect having been made to all the ports in the district some time previously.

ORGANIZATION.

The number of employés engaged was twenty-one, and the organization of the station was effected as follows:

James H. Maury, sanitary police, and also deputy collector of the port of Sapelo was placed at the north end of Blackbeard Island in charge of the anchorage in Sapelo Sound. One man was detailed to act under him as boatman and messenger. Dr. William F. Brunner, hospital stewart, was appointed assistant to the inspector, and placed in charge of most of the outdoor work and all the stores, except the commissary. James B. Allen, chief nurse, was placed in charge of the commissary department. Van B. Avery, pilot, acted also as captain, and had command of the steamer; an engineer and a deck-hand were assigned to duty under him. R. C. Ferrill, clerk, had charge of the office and records. Five carpenters were employed under the personal direction of the inspector. J. D. Martin, with two assistants, was detailed for work upon a lighter. The two other carpenters were engaged upon the buildings. The laborers were employed in policing the camp, handling lumber, and rendering such other assistance as the carpenters required.

All the employés, with the exception of the carpenters, were engaged for the season, and one-fourth of the wages due at the end of each month retained as a guarantee of good faith, a contract to that effect being entered into at the date of engagement. This contract also provided that the parties to it were bound to be employed about the sick, or on board infected vessels, when required.

The operation of this provision was most beneficial in its effects. It had a tendency at the outset to exclude undesirable characters and rendered those accepting employment more contented, as their minds were not unsettled by the influence and example of those leaving during the season. This state of affairs was in marked and agreeable contrast to the experience of the past; the frequent changes in the *personnel* of the force seriously impairing its efficiency and being a constant source of anxiety

and annoyance to the inspector. In selecting and organizing the corps of employés the object desired was to secure the requisite number of acclimated persons who, while capable of handling infected vessels and moving the sick, yet would, till an arrival called for these special services, prove efficient in improving the equipment and general condition of the station. It was found that able seamen were more apt to be possessed of these qualifications than any other class.

WORK.

In the absence of vessels at the station this season, the work of the employés was directed chiefly to the construction of a lighter and the erection of buildings. The work accomplished may be briefly stated as follows:

A lighter for the removal and supply of ballast, 40 feet long and 15 feet wide, was constructed of the best materials, and in the most thorough manner. Cypress was used for sides and planking, and live-oak for knees, with sheathing and fastenings of composition metal up to the load line, and galvanized iron above this, all affording, as much as possible, protection against the corrosive action of salt water and the ravages of the toredo.

The surgeons' quarters were improved by the addition of a piazza on three sides. There were erected a boat-house for the protection of the boats purchased in New York, and a shed for the steamer's supply of coal, capable of holding forty tons. A well for the supply of fresh water to the steamer was dug, and a small floating dock was constructed. The rise of the spring-tides being about 9 feet this style of landing was more convenient than a wharf. Other improvements of a minor kind and the routine duties of the camp served to keep the force regularly employed five days in the week. Saturday morning was devoted to policing camp and quarters; liberty was given in the afternoon. General inspection was held every Sunday morning.

In deciding on the character of the work upon which the force should be employed it was determined, in view of the failure on the part of Congress to make any appropriation for Sapelo, to use the fund allowed by the National Board of Health for the maintenance of the station for the erection of temporary improvements, in order to supply, as far as possible, the want of permanent structures.

HEALTH.

During the summer, and till near its close, the sanitary condition of the station was good. About the middle of September periodic fever began to prevail among the residents on the adjacent part of Sapelo Island opposite the station and distant half a mile. All the residents there are colored. One or two mild cases of the same disease appeared soon after at the station.

After the close of the station on the first of October, out of 13 white persons who had been at the station all summer, 10 suffered from attacks of periodic fever, half of which were quite severe; 1 being of the congestive type. The 5 colored employés did not suffer, so far as is known.

As the site of the station is dry and clean it seems probable that the sources of the malarial poison are some undrained ponds on Sapelo Island, which, being over a mile distant, with pine forest, a river, and open salt-marsh intervening, were not at the time the station was located thought to be dangerously near. The view here expressed is strengthened by the facts that the residents of Sapelo, though colored, were attacked before the whites at the station, and that every occasion when this fever has prevailed at the station it has followed the prevalence of west winds, *i. e.*, from Sapelo Island.

The sanitary experience of the three seasons that the station has been in operation may be summed up as follows: First season, healthy; second, sickly in midsummer; third, very sickly after the close.

RELATIONS TO THE DISTRICT.

No vessels were ordered to the station this year. No infected vessel arrived at any port tributary to Sapelo. The local authorities, with the exception of Fernandina, seem to prefer taking care of suspected vessels at their own quarantines. I regard this practice as fraught with considerable danger to the country. In all other respects the relations between the management of the station and the local authorities of the district are satisfactory. It is suggested that it would be well to favor the continuance of this status of affairs by a personal visit by your inspector annually to each port in the district, prior to the opening of the quarantine season.

Respectfully submitted.

W. H. ELLIOTT,
Inspector, National Board of Health

APPENDIX I.

ON THE MARITIME SANITARY SERVICE OF THE UNITED STATES, AND THE RELATIONS OF NATIONAL AND STATE AUTHORITIES.

By Stephen Smith, A. M., M. D.,
Member National Board Health.

The act of Congress approved March 3, 1879, entitled "An act to prevent the introduction of infectious and contagious diseases into the United States, and to establish a National Board of Health," provides, among other things, that the National Board shall give "special attention to the subject of quarantine, both maritime and inland, and especially as to regulations which should be established between State and local systems of quarantine and a national quarantine system."

As at the period of the passage of this law there were only State and local systems of quarantine in existence in this country, it is proper to infer as follows:

1. That Congress did not regard State and local systems of quarantine adequate to meet all the emergencies that had arisen or that might arise in the prevention of the introduction of contagious and infectious diseases into this country from foreign countries.

2. That Congress contemplated the ultimate establishment of a national quarantine system, and that it intended that such regulations should be made between State and local systems of quarantine and the national quarantine system as would secure harmony of action, and would give a complete and effective system of quarantine to the United States.

The motive to Congressional action upon this subject was undoubtedly the great yellow-fever epidemic of 1878. Long before the regular session of Congress of that year, the popular agitation of preventive measures had become so absorbing and intense that the action of the national legislature was inevitable. The prevention of future epidemics of this pestilence was no longer a matter of mere local concern, but was now suddenly lifted into the realm of national legislation.

Although the great question of preventive measures against future epidemics took precedence of all other subjects, Congress did little more during that short session than collect information, through a board of experts, as a basis of legislation, and establish, according to its suggestion, a National Board of Health, with power only to investigate causes of disease, collect information, and advise the Departments of Government on sanitary questions.

One of the subjects on which the board of experts reported quite fully was the organization of a national quarantine system. It is reasonable to believe that the suggestions of this board had great weight with Congress, and led to the inquiry as to the regulations which should be established between State and local systems of quarantine and the national quarantine system.

During the extra session which followed the close of the regular session, Congress was compelled by the pressure of public sentiment to deliberately re-examine the whole subject, and make adequate provision to meet the contingency of the recurrence of the epidemic. The result of its deliberations was the passage of two additional acts. In the first of these acts, approved June 2, 1879, though no quarantine system is proposed, provision is made to meet defects in the existing systems of a most important character. The provisions were amplified by the act approved July 2, 1879. In furtherance of the same object of perfecting measures of protection against the introduction of contagious or infectious diseases from foreign countries, Congress passed a joint resolution, approved May 14, 1880, authorizing the President of the United States—

"To call an international sanitary conference to meet at Washington, to which the several powers having jurisdiction of ports likely to be infected with yellow fever or cholera shall be invited to send delegates, properly authorized, for the purpose of securing an international system of notification as to the actual sanitary condition of ports and places under the jurisdiction of such powers and vessels sailing therefrom."

The invitation of the President, issued in pursuance of this resolution, was cordially responded to by twenty-eight nationalities. The conference met on the 5th of January, 1881, at Washington, and, during a session of two months, discussed some of the more important questions relating to international sanitary co-operation. There was great unanimity of opinion; and certain conclusions were definitely reached, which we feel authorized to consider as practically adopted, and a part of our national quarantine system.

An examination of the recent legislation of Congress shows that our quarantine system has undergone some very remarkable changes within the last three years. It has, in fact, been so enlarged in its scope, and in the methods of administration, as to have made State and local quarantines a branch of a far more extended system of operations. In this larger capacity the development of our sanitary maritime organization evidently tends to a system of combined national, State, and municipal defenses against foreign pestilences of the most effective character.

It is the purpose of this paper to consider somewhat in detail the bearing of the recent acts of Congress on our quarantine system, and thereby determine the regulations which should be, and, indeed, which have already been to some extent, established between State and local systems of quarantine and a national quarantine system.

It must be premised that the term "quarantine" should no longer be employed to designate the newly developed system, or, if employed, should be completely separated from its derivative meaning, and receive a new definition. It should no longer imply time, but should be a general and convenient term for a department of government devoted to the protection of the public health from the importation of contageous and infectious diseases. A better designation than "quarantine" would be "the maritime sanitary service." The duties of this service will no longer be the mere detention of vessels, cargoes, passengers, and crews, as a means of preventing the introduction of contagious and infectious diseases into the United States, but, under an enlightened management, it will aim to apply to ship sanitation all the resources of sanitary knowledge in order to render the great water-ways of commerce and travel free from danger to life or health, and to prevent vessels from ever being the generators or carriers of infection.

In sketching the several branches of this service it will be convenient and pertinent to examine them in the following order: 1. International co-operation. 2. The collection and distribution of sanitary information. 3. Maritime rules and regulations. 4. Maritime sanitary inspections. 5. The sanitary care of vessels arriving at the ports of the United States. 6. Co-operation of national and State authorities. 7. The organization of new, and the strengthening of defective, quarantines.

I.—INTERNATIONAL SANITARY CO-OPERATION.

Doubtless the greatest and most important advance made in arresting the spread of the graver forms of pestilential diseases has been in the co-operation of commercial nations in uniform and well matured measures of defense and protection. The civilized nations of the world are beginning to realize that contagious and infectious diseases are the common foes of mankind, and that their carriers, whether persons, goods, freight, cargoes, or vessels, should be arrested, and relieved of infection before they are allowed to continue their travels. No commercial nation can adequately protect itself from the invasion of contagious or infectious diseases from other countries with which it is in direct communication, without either applying restrictive measures upon its commerce and travel, or securing the co-operation of other nations. This fact has come to be more and more realized in modern times, owing to the immense extension of the commerce of the world and the greatly increased facilities and spread of ocean and railway travel and traffic. In several instances nationalities have combined their efforts in well-concerted measures for mutual protection against the invasions of cholera and the plague, and the result has been most satisfactory.

In this country it has proved practically impossible to enforce preventive measures against the importation of yellow fever, owing to the failure hitherto to secure international co-operation.

Some of the most important features of the law of Congress, approved June 2, 1879, were rendered null and void by the indifference in some cases, and the actual hostility in others, of nations having intimate commercial relations with the United States. Secretary Evarts thus forcibly stated the facts in a memorandum transmitting the resolution of Congress inviting commercial nations to an international sanitary conference. He says: "This resolution had its origin in the practical difficulties which have been encountered in the administration of the regulations and rules recommended by sanitary experience and framed by the legislation of the country to the end of preventing the introduction and spread of yellow fever, cholera, and other contagious or infectious diseases in the territory of the United States. The extensive prevalence of yellow fever in certain parts of this country during the past two

years, and the almost continual existence of the danger of the introduction of such contagious or infectious diseases as yellow fever and cholera by vessels coming to this country from infected ports abroad, gave rise to such legislative measures; but the difficulty in their application has been chiefly owing to the fact, that in certain foreign ports where infectious or contagious diseases have existed, or were supposed to exist, the local authorities have shown some hesitation as to co-operating with the consular and medical officers of the United States in carrying out regulations deemed essential by this Government as a sanitary safeguard. Moreover, in consequence of the vague and untrustworthy evidence obtainable in some cases as to the sanitary condition of suspected foreign ports, vessels coming thence to the United States have, in some instances, as it has afterwards appeared, been subjected to unnecessary quarantine in the ports of this country. On the other hand, vessels from non-infected ports of the United States have been compelled to submit to like unnecessary and vexatious delays by the quarantine regulations of other countries, based upon imperfect knowledge of the sanitary condition of American ports."

It is evident, therefore, that international regulations in the nature of treaties, designed to secure the co-operation of commercial nations in concerted measures for the prevention of the exportation and importation of pestilential diseases, are essential to any complete and effective system of quarantine.

The following important methods of international co-operation are desirable, and are now attainable, as is shown by the action of the recent international sanitary conference at Washington:

1. The regular and systematic communication, among the contracting nationalities, of current information in regard to the public health of each, so far as relates to the existence or prevalence of contagious or infectious diseases, and the precise localities where such diseases exist.

This subject formed the principal topic of discussion at the recent international sanitary conference. Of the desirability of such information as a part of any organized scheme to prevent the importation of contagious or infectious diseases into a country, there was complete unanimity. The only difference of opinion occurred in the discussion of methods. It may be regarded, therefore, as a settled point in the system of international co-operation, that this proposition will be agreed upon.

2. An international bill of health, which shall be an accurate statement of the sanitary condition of the vessel, cargo, passengers and crew, and of the public health of the port of departure and the neighborhood, and of the infectious and contagious diseases prevalent.

This subject was also fully considered by the late international conference, and a form of a bill of health agreed upon.

II.—THE COLLECTION AND DISTRIBUTION OF SANITARY INFORMATION.

It is not only necessary to an effective system of maritime sanitary service that there should be international co-operation, at least to the extent above indicated, but a branch of that service should be devoted to the collection of sanitary information, and its distribution among the officers of the service at home and abroad. If such information could be obtained as would present an accurate exhibit of the sanitary condition of all foreign countries, and of the principal cities, towns, and villages of the United States, and such information could be furnished immediately to all officers engaged in the maritime service, it is evident that it would prove of immense importance to the effectiveness of that service. For the accomplishment of this object Congress has made the following provisions:

"It shall be the duty of the National Board of Health to obtain information of the sanitary condition of foreign ports and places from which contagious and infections diseases are or may be imported into the United States; and to this end the consular officers of the United States, at such ports and places as shall be designated by the National Board of Health, shall make to said board of health weekly reports of the sanitary condition of the ports and places at which they are respectively stationed, according to such forms as said board of health may prescribe; and the board of health shall also obtain, through all sources accessible, including State and municipal authorities throughout the United States, weekly reports of the sanitary condition of ports and place within the United States; and shall prepare, publish, and transmit to the medical officers of the marine hospital service, to collectors of customs, and to State and municipal health officers and authorities, weekly abstracts of the consular sanitary reports, and other pertinent information received by said board, and shall also, as far as it may be able, by means of the voluntary co-operation of State and municipal authorities, of public associations and private persons, procure information relating to the climatic and other conditions affecting the public health."

In accordance with this statute the Department of State has issued instructions to consular officers directing them to furnish to the National Board of Health the requisite information, and such information is now regularly received from all parts of the

world. The board of health has, on its part, organized a system of correspondence and statistical mortality returns throughout the United States, which secures a body of information in regard to the condition of the public health of the ports and places, and of the great centers of population, of immense value to all sanitary authorities. This information, properly collated, with an abstract of the consular reports, and other pertinent matter, it transmits weekly to the authorities and officers specified in the statute. The following order has also been issued by the National Board:

"Whenever any vessel shall leave an infected port, or, having on board goods or passengers coming from any place or district infected with Asiatic cholera, yellow fever, or plague, shall leave any foreign port, bound for any port of the United States, the consul, consular officer, or representative of the United States, at or near such port, shall immediately give information thereof by telegraph to the National Board of Health at Washington, D. C., reporting the names, date of departure, and port of destination of such vessel."

The diffusion of this information has added largely to the efficiency of every branch of sanitary service in this country, and especially to that devoted to the prevention of the importation of pestilential diseases. No vessel can now leave an infected port without the fact becoming immediately known to the National Board, which at once notifies the health officer of the port of her destination.

III.—MARITIME SANITARY RULES AND REGULATIONS.

One of the most important branches of a martime sanitary service must be that devoted to securing the best sanitary condition of vessels, their passengers, cargoes, and crews. In order to accomplish this object, rules and regulations must be made, and enforced upon masters and owners at all times, and wherever the vessels may be. Congress has conferred upon the National Board of Health the power to make—

"Such rules and regulations as are authorized by the laws of the United States, and necessary to be observed by vessels at the port of departure, and on the voyage, where such vessel sails from any foreign port or place at which contagious and infectious diseases exist, to any port or place in the United States, to secure the best condition of such vesssel, her cargo, passengers, and crew; and, when such rules and regulations have been approved by the President, they shall be published, and communicated to and enforced by the consular officers of the United States."

In compliance with this law the National Board of Health made the rules required, and communicated them to the consular officers of the United States. They therefore form a part of this maritime sanitary service of the country, They are designed to accomplish the following reforms on all vessels in foreign ports bound for any port of the United States:

1. To secure perfect cleanliness of the vessel before the cargo is received.
2. To prevent any infected cargo or material being taken, or person from going on board.
3. To secure cleanliness and ventilation at sea.
4. To require adequate care of the sick on the voyage, and the complete isolation of an infections or contagious disease which may occur.
5. To obtain sufficient space for passengers, so that there will not be overcrowding.

IV.—MARITIME SANITARY INSPECTIONS.

The rules and regulations for securing the best sanitary conditions of vessels would be useless, unless enforced by proper and timely inspections. The opportunity for such inspections occurs at but two places; viz (1), at the port of departure; and (2) at the port of arrival.

1. At the port of departure or foreign port, the only person competent to perform the duty of inspection is the consul. And, being the officer who certifies to the bill of health, he is at once recognized as the person upon whom this duty must devolve. Congress accordingly has imposed upon consuls the duty of inspection, and of enforcing the rules and regulations adopted by the board of health. It may happen that at infected ports the consul may require the aid of a skilled medical officer; and in that case Congress has authorized the President to detail a medical officer to serve in the office of the consul at any foreign port for the purpose of making the inspection, and giving its certificates. At the present time the consuls of the United States are under instructions to make the required inspections, and at Havana a medical officer serves in the office of the consul. This new feature of our quarantine system, if rigidly carried out in all of its details, would prove a radical step taken to prevent vessels, cargoes, passengers, and crews from being the carriers of infection.

2. At the port of arrival the inspection must be made by the health officer. This officer is usually under the jurisdiction of the State, and his duty is to enforce the local quarantine regulations. Congress recognizes this fact, but also implies that its

own jurisdiction should be co-ordinate with that of the State. The language of the statute is as follows:

"It shall be unlawful for any merchant ship or vessel from any foreign port where any contagious or infectious disease exists, to enter any port of the United States, except in accordance with the provisions of this act, and all rules and regulations of State boards of health, and all rules and regulations made in pursuance of this act."

Evidently Congress assumed that the rules and regulations of the State, and those made in accordance with its own statute, would be in harmony, and that no conflict could arise; for both State and national authorities were aiming, in their respective spheres, to accomplish precisely the same object by the same means.

It is very evident that much of the success of our quarantine system must depend upon an intelligent and thorough system of sanitary inspection at the port of arrival. If vessels which neglect to comply with the rules and regulations designed to secure their proper sanitary condition are allowed free admission to the ports of the country, one of the most important elements of an effective maritime service will be of no avail; but, as it is for the highest interest of the State that its quarantine be so administered as to prevent the invasion of pestilential diseases from foreign ports, it must be assumed that the inspections of vessels at our ports will be efficient. That there should be harmony of opinions and practice between national and State authorities, the National Board of Health at the outset invited the principal health officers of the United States to its aid in preparing "rules and regulations to be adopted and observed at all ports of the United States"; and the code of regulations agreed upon at this conference were such as their experience dictated.

V.—THE SANITARY CARE OF VESSELS ARRIVING AT THE PORTS OF THE UNITED STATES.

Every system of maritime sanitary service is imperfect which does not afford all of the appointments necessary, not only to prevent a vessel arriving with a contagious or infectious disease on board from introducing that disease into the country, but to enable that vessel to be purified and returned in the shortest possible time to commerce. A quarantine establishment, fully equipped to meet every emergency, must have, 1, a location for the boarding and detention of vessels; 2, quarters for the detention of passengers not sick; 3, hospital accommodations for the sick; 4, lighters, wharves, and warehouses for receiving and storing cargo; 5, a chief medical officer and such other officers or agents as may be necessary for securing the examination, cleansing, and disinfection of the vessel and its cargo, passengers, and crew; 6, boats, apparatus, &c., necessary for administration; 7, quarters for officers and men; 8, burial ground. It is true that at many ports of the United States the more expensive equipments of such an establishment would seldom be put in requisition, but it is equally true that they might be required at any port. And it is the want of these facilities at critical moments that has resulted in the introduction of pestilences of the most virulent and fatal form. From personal inspection, I am satisfied that there is not a State or municipal quarantine in the United States to-day competent to give an infected vessel, cargo, passengers, and crew that sanitary care which the exigencies of modern commerce and travel have a right to demand, and which science has proved expedient and proper; nor is it surprising that neither States nor municipalities have organized these establishments, which are so expensive in construction and maintenance, and so seldom absolutely required, and yet of their absolute necessity there can be no doubt. Every season the emergency arises demanding their employment at some point or points on our extensive coast.

The State and local quarantines of the United States, with two or three exceptions, are little more than boarding-stations, having no other facilities for the sanitary care of vessels than such as can be supplied and performed on board of each individual vessel. While these facilities are adequate to prevent the introduction of the mild forms of contagious and infectious diseases, as scarlet fever, measles, &c., they are not adequate when vessels arrive infected with yellow fever, or having cases of cholera on board. The former class of vessels can be sufficiently cleansed and disinfected in any harbor without danger to the communities adjacent, but vessels of the second class should never be allowed to touch the mainland until they, with their cargoes, passengers, and crews are entirely free from infection. Such vessels should be treated in establishments located on uninhabited islands, and which have every necessary arrangement for treating the sick, for protecting the well while under observation, for storing, cleansing, and disinfecting cargoes, and for thoroughly overhauling every part of the vessel liable to retain infection, and applying the necessary remedies. In order to supply this deficiency in our quarantine system Congress passed the following enactment:

"And the board of health shall have power, when they may deem it necessary, with the consent and approval of the Secretary of the Treasury, as a means of preventing the importation of contagious or infectious diseases into the United States, or into one

State from another, to erect temporary quarantine buildings, and to acquire, on behalf of the United States, titles to real estate for that purpose."

In accordance with the provisions of this law, and under the advice of competent counsel, and with the consent of the Secretary of the Treasury, the National Board of Health determined to supplement the defects of State and local quarantines by establishing on insular positions, at suitable points on the coast, refuge stations for the special sanitary care of infected vessels, their cargoes, passengers, and crews. The principle which governed the action of the Board was this, viz: 1. No vessel infected with yellow fever should be allowed to come to the mainland until it has been satisfactorily purified and relieved of infection. 2. To accomplish this object, establishments should be provided on uninhabited islands, sufficiently remote from the mainlands to prevent all possible communication of infection to adjacent communities, and equipped with every appliance necessary for the treatment of the sick, for the care of the well, and for the purification of the cargo and vessel. It was believed, that if a sufficient number of these thoroughly equipped stations were provided, so that every infected vessel bound to a port of the United States could be thoroughly purified before it approached the mainland, the purposes of Congress would be fulfilled, and a most important addition would be made to our national defenses against the importation of foreign pestilences. Three stations were accordingly at once undertaken, and located at points where they were deemed most useful and immediately necessary, viz, at Ship Island, on the Gulf coast; at Sapelo Sound, Blackbeard Island, on the South Atlantic coast; and at Norfolk, Va. The National Board proposed to provide at each station the following outfit:

1. Places for boarding, detaining, cleansing, and disinfecting vessels.
2. Quarters for passengers and crews of infected vessels who are not sick.
3. Hospital accommodations for the sick.
4. Wharf, warehouses, and fumigating house, for receiving, storing, and fumigating cargoes.
5. Such medical attendance and supervision as is necessary for securing the examination of the vessel, its cargo, passengers, and crew, and for such cleansing and disinfection as may be necessary.
6. Boats, apparatus, &c., for the proper administration of the station.
7. Quarters for the officers and men.
8. Burial ground.

The administration of these refuge stations is devoted exclusively to the sanitary care of such vessels, their cargoes, passengers, and crews as voluntarily enter them *en voyage*, or are sent to them by the health officers of the neighboring coast quarantine stations. They are in no sense boarding-stations to intercept incoming or passing vessels. This latter function belongs exclusively to the State or local quarantines of the vicinity, and the refuge stations in no wise interfere with or supersede these establishments. Nor does the administration of these stations exercise any compulsory power over even infected vessels entering the coast quarantines. The latter may, if they choose, retain infected vessels, and require them to perform such acts of purification as they may direct. The refuge is simply the national authority ready to cooperate with the State or local authorities to prevent the introduction of contagious or infectious diseases into the United States by thoroughly purifying infected vessels.

Viewed from the stand-point of experience and of sanitary knowledge, there can be no doubt that the State and local quarantines of this country can be made far more effective by the establishment and maintenance of a suitable number of properly located refuge stations to which infected vessels must resort for thorough purification before they are allowed to come into the harbors of the coast. Nor can there be the slightest conflict of authority. The State and local quarantines will perform the same functions as at present, only recognizing the refuge as the place where infected vessels must perform quarantine on their own order, while the refuge would be devoted to the proper purification of the vessels sent to it and certificate of their immunity from infection. Nor will this addition to our quarantine system prove embarrassing to commerce when fully developed and administered in good faith by all parties. If, for example, refuge stations were located at Galveston, Ship Island, Key West, Sapelo, Norfolk, the Delaware Breakwater, New York, and Boston, the coast would be well provided with these establishments. Infected vessels coming from foreign ports would go to such a station *en route*, and undergo the necessary purification before attempting to enter any port. Such vessels would thereby undergo far less delay than at present, owing to the rapidity with which they would be cleansed.

The plan of refuge stations at convenient distances from local ports, now a part of our quarantine system, is not altogether new. The same principle enters into the quarantine system of Great Britain. Her coast is divided into convenient sections, and a general quarantine station is designated for each. For example, vessels arriving from certain ports, and bound to the ports of London, Rochester, Faversham, and any creeks or places belonging to or within any or either of the above ports, must perform quarantine in Standgate Creek. Again, such of them as shall be bound to

the ports of — (thirty in number are mentioned by name)— shall perform quarantine in Whitebooth Roads, between Hull and Grimsby. In this manner all the ports of the kingdom are grouped; and a given place is designated where all vessels liable to quarantine, and bound to one of the ports of the group, must resort before attempting to enter the port of destination. Not only no hardship results to commerce and travel from this system, but it is the united testimony of masters and owners of vessels that the system greatly aids them in business.

VI.—CO-OPERATION OF NATIONAL WITH STATE AND MUNICIPAL AUTHORITIES.

But Congress did not limit the co-operation of the national with State and local authorities to the establishment of these refuges, but provided methods by which every local quarantine could be strengthened when necessary by national aid. The following clause of the law expresses the purposes of the legislative body:

"The National Board of Health shall co-operate with and, so far as it lawfully may, aid State and municipal boards of health in the execution and enforcement of the rules and regulations of such boards to prevent the introduction of contagious and infectious diseases into the United States from foreign countries."

This law has been construed by the National Board to mean that whenever a local quarantine is defective in those particulars which render it inadequate to the proper sanitary care of uninfected vessels, and the State or municipality has no available means for that purpose, aid may be rendered by that Board to the extent of supplying the deficiencies. But in no case is the National Board authorized to construct and equip local quarantines for the purpose of rendering them competent to care for vessels infected with yellow fever or cholera. The establishments for this latter purpose must be provided separately, and each one must be so located as to meet the wants of many ports.

This is, therefore, a wise provision, and, properly carried out, capable of effecting important results. There are many small seaport towns that are very liable to be visited by vessels infected with yellow fever, but which have not the means necessary to make suitable provision for the inspection or care of vessels. A very small amount of aid to such ports at critical times has the effect of preventing the introduction of yellow fever into the country.

VII.—ABSENCE OF QUARANTINE AND INADEQUATE QUARANTINE REGULATIONS.

Finally, there remained two possible contingencies that might require the national authority to act to prevent disastrous consequences, owing to a lax system of quarantine. One was the possible failure of the State to create and maintain a quarantine at some important port; and the other was the possible defects in the regulations of any existing quarantine. To meet these contingencies, Congress provides as follows:

"At such ports and places within the United States as have no quarantine regulations under State authority where such regulations are, in the opinion of the National Board of Health, necessary to prevent the introduction of contagious and infectious diseases into the United States from foreign countries, or into one State from another, and at such ports and places within the United States where quarantine regulations exist under the authority of the State, which, in the opinion of the National Board of Health, are not sufficient to prevent the introduction of such diseases into the United States, or into one State from another, the National Board of Health shall report the facts to the President of the United States, who shall, if in his judgment it is necessary and proper, order said Board of Health to make such additional rules and regulations as are necessary to prevent the introduction of such diseases into the United States from foreign countries, or into one State from another, which, when so made and approved by the President, shall be promulgated by the National Board of Health and enforced by the sanitary authorities of the States, where the State authorities will undertake to execute and enforce them; but, if the State authorities shall fail or refuse to enforce said rules and regulations, the President may detail an officer or appoint a proper person for that purpose."

By this provision of law, if the National Board of Health is vigilant, there can be no failure to maintain an unbroken and efficient chain of quarantine posts the entire length of our marine coast.

CONCLUSIONS.

If, in conclusion, we group the several branches of this system of maritime sanitary service with a view to distribute the functions of the national and State authorities, we shall have the following exhibit:

1. The national authority is required to secure—
(*a*) International sanitary co-operation.
(*b*) The collection and distribution of sanitary information.
(*c*) The preparation of maritime sanitary regulations.

(*d*) The enforcement of maritime sanitary inspections in foreign ports.
(*e*) The erection and maintenance of refuge stations.
(*f*) The aid of State authorities.
(*g*) The organization of quarantine where none exist.
(*h*) The power to add necessary rules to any deficient quarantine.

2. The State authority is required to secure the organization and maintenance of efficient quarantine service at ports within the States.

This duty includes—
(*a*) The inspection of vessels.
(*b*) Provision for the care of vessels not infected with cholera or yellow fever.
(*c*) A competent health officer.
(*d*) Making and enforcing rules and regulations governing the quarantine.

From this schedule of functions the conclusion is inevitable that our maritime sanitary service, though greatly extended, is practically one organization, and one department of public duty. It must of necessity be partly under national and partly under State authority, but there is nothing incompatible in the exercise of this authority by the separate governments. The system will be one compiete whole when all its machinery is properly adjusted, and will work for the accomplishment of a given object, in which the nation and the State are equally interested. The end sought is the protection of the State and nation against the invasion of a common enemy. The national authority makes alliances for international co-operation with friendly foreign powers; makes rules and regulations for securing the best sanitary condition of vessels, their cargoes, passengers, and crews, and directs its consular officers to enforce them in foreign ports; erects and maintains the strong outer defenses or refuges; stands ready to aid the States wherever and whenever they require or need assistance; watches along the whole line of coast defenses, and, wherever there is a weak or unprotected post, immediately supplies the needed force or aid. The State authority stations its sentinels at all of the approaches to its territory, who vigilantly examine every suspected vessel, and refuse admission to every ship which has not fully complied with the rules and regulations of its own and of the national authority. All vessels requiring only ordinary cleansing and care are at once returned to commerce, while the infected yellow-fever ships are sent to the nearest refuge station for an exhaustive purification.

From this review it is apparent that Congress, without in any wise disturbing the existing State and local quarantine systems, has made them an integral and essential part of a national system of quarantine, which, when fully developed, will be complete in all its parts. Legislation is still required to co-ordinate and complete all its parts. International co-operation should be extended so as to include general ship sanitation, and the creation of a system of refuge stations for infected vessels at points on the great routes of commerce with the tropics; the system of home refuge stations should be completed, so that every infected vessel approaching our coast could find prompt care and certain relief without departing far from her accustomed route; the local quarantines throughout the country should be .placed under the jurisdiction of the State boards of health of their respective States. But if the same wise and enlightened statesmanship, which has guided Congress and State legislatures thus far in sanitary legislation, continues to perfect and enlarge our system of protection against foreign pestilences, in the near future the most efficient system of maritime sanitary service which has ever been organized will be assured to the United States.

APPENDIX K.

REPORT OF THE SUPERINTENDENT OF THE MISSISSIPPI RIVER INSPECTION SERVICE, MEMPHIS, TENN.

OFFICE OF THE SUPERINTENDENT, RIVER INSPECTION SERVICE,
Memphis, Tenn., October 3, 1882.

SIR: In obedience to telegraphic instructions fron the secretary, May 9, the system of inspections on the Mississippi River for the season of 1882, under the direction of the National Board of Health, was resumed on May 15, under the rules and regulations of preceding years. The only station put in operation on this date was the one at the foot of President's Island, below Memphis, Tenn., with Dr. John E. Black, of that city, in charge. The establishment of similar stations at Cairo, Ill., and at Bayou Sara, La. (mouth of Red River), was not called for throughout the season, and the one below Vicksburg, Miss., was opened immediately on the appearance of a case of yellow fever in New Orleans, June 26.

Dr. Luther Sexton, of Wesson, Miss., was appointed inspector, and conducted the station until its close. Within this period, beginning May 15 and ending September 30, at Memphis, and beginning July 1 and ending September 30, at Vicksburg, the total number vessels of all descriptions inspected was 539, carrying 24,854 persons, passengers, officers, and crews. There is a considerable decrease in the total number of boats inspected and persons on board, which is due to the fact that inspections were not begun at Memphis until fifteen, and at Vicksburg sixty, days later than last season. Below the totals are given in tabulated form:

Inspections.	Memphis.	Vicksburg.	Total.
Passenger and freight packets	187	78	265
Officers and crews of same	7,020	4,891	11,911
Passengers	8,221	2,102	10,323
Tow-boats	33	14	47
Officers and crews of same	1,652	842	2,494
Barges and flat-boats	158	56	214
Steam tugs	5	8	13
Officers and crews of same	57	69	126
Tonnage:			
Passenger and freight packets	140,268	62,567	202,835
Tow-boats	15,046	7,451	22,497
Barges, flat-boats, &c	280,000	93,312	373,312
Total tonnage	435,314	163,330	598,644

It is gratifying to report that the inspectors discovered a marked improvement over former years in the sanitary condition of the boats, plainly demonstrating that the officers and owners see the benefits of constant cleanliness of every part of their craft. The officers in charge show an eagerness to gain intelligent advice as to the best manner of ridding deck-rooms, water-closets, &c., of objectionable odors, and the means to be employed to check decomposition of the vegetable matter that unavoidably finds its way into the bilge, under dunnage, and other hidden quarters of the boat. It is now their custom to have a supply of copperas, lime, and carbolic acid as disinfectants on most of the boats, and information as to the most effective manner of their disposal is usually asked of the inspector at the stations.

In the matter of improving the sanitary condition of the boats no compulsory measures were necessary, and no contraband goods or boat stores were destroyed, as in other seasons. A few instances were reported where the officers failed to get the inspector's certificate in New Orleans, and for this violation of a municipal ordinance of the city of Memphis the owners of two small tug-boats were fined in the city

courts. The tow-boat Port Eades, of the Mississippi Valley Transportation Company, refused to allow Inspector Sexton on board at the Vicksburg station, which was the only interruption of any consequence at that station during the season. On arrival at the President's Island station the reason given for this was that the proper certificate was obtained in New Orleans, but was misplaced, and the officer in charge supposed he would not be allowed to continue his voyage without it. This fact was reported to Supervising Inspector Chaillé, at New Orleans, who confirmed the statement of the officers as to the requisite certificate having been obtained, but was lost *en route*. With these unimportant exceptions the boats reported promptly at the stations, and the officers in charge offered every facility to the inspectors for carrying out the rules of the service, and were uniformly courteous and obliging.

During the inspection season the total number of persons reported ill was 39, being about in equal ratio per thousand to former years. One death, that of a colored deckhand, from malarial toxæmia, complicated with dysentery, occurred on board the W. P. Halliday, and was buried at President's Island. Appended is a list of the number ill and the general character of the diseases found:

Malarial fever (intermittent and remittent)	32
Malarial toxæmia	1
Congestive malarial fever	2
Acute rheumatism	1
Dysentery	2
Phthisis pulmonalis	1
Total	39

Several bodies were shipped from points on the river, but in each instance a certificate of the cause of death accompanied the corpse.

SICKNESS AMONG THE EMPLOYÉS.

At the time the inspections were resumed, on May 15, the high water of the previous two months had not subsided, but the site of the President's Island station was then under water. After its subsidence a great mass of decaying vegetation was left under and near the quarters of the men. Though lime and disinfectants were freely used and quinine liberally employed as a prophylactic, yet malarial fever, chiefly tertian in type, soon occurred, and at no time during the entire season has every occupant been free from the regularly recurring attacks.

Frequent changes were made in the force, each new one repeating the experience of his predecessor. Though much inconvenience resulted from this illness, there has not been a single day's interruption in the inspections at either the President's Island or Vicksburg stations. The type of malaria at the Vicksburg station was more severe than that at the Memphis station and less amenable to treatment. Two of the employés were wholly incapacitated for the duties of their positions, and were transferred to the Vicksburg City hospital and from thence to their homes. On September 1 the superintendent relieved Inspector Sexton until September 5, to allow him a short period for recuperation, after which time he resumed his duties uninterruptedly until the season's close, but still having periodical returns of malarial paroxysms, but in a milder form. It is proper to state that the inhabitants, with rarely an exception, in the region of the spring overflow have suffered to an extent hitherto unknown with malarial attacks. As there was no improvement in the condition of the men by September 15, the superintendent deemed it advisable to change the locality of the inspection station. The health authorities of Vicksburg and the executive committee of the National Board approving this course, the barge was accordingly towed up to within 3 miles of the city and 1 mile below the boat landing. This move occasioned no inconvenience to the river craft, and has been beneficial to the health of the station employés.

In view of the many interruptions in former years caused by illness, which is almost inevitable from the necessary exposure to malarial influences, the superintendent will recommend that at the beginning of each inspection season an extra inspector be appointed to relieve the others in case of illness; or, if it is practicable, to have them relieve each other at stated intervals, having one man off duty all the while. The superintendent feels that some measure of this kind is necessary from experience this season. A new man cannot always be found to supply the place speedily in the event of a sudden resignation or illness. As for the minor employés, their places can be filled without any interruption.

THE SANITARY FLEET—ITS CONDITION, ETC.

The sanitary fleet now embraces the following: One patrol boat, H. H. Benner; two steam launches, Sentinel and Lookout; three hospital barges; one disinfecting boat; one storage boat, J. W. Vansant. At the present writing (October 4) the

launch Lookout and hospital barge No. 10 are in tow for Memphis, to be laid by for the winter; these are included in the list above.

The superintendent regrets to report the loss of one of the steam launches, the Picket, caused by its upsetting and sinking in the Memphis harbor while in tow for Vicksburg. It was put in charge of experienced river men with full knowledge of the difficulty of towing a boat of its character, and all precautions taken. It is in from 50 to 60 feet of water, at low-water mark, in a swift current, and though an experienced diver contemplates a search for it, its ultimate recovery is doubtful.

The Benner and disinfecting boat are in admirable order and ready for service on short notice. Aside from the damage incidental to their use at the stations, and being towed from point to point, the hospital barges are as good as when built.

The repairs necessary are unimportant, and can be done by Caldwell while in his charge for the winter. Each barge has the necessary equipment of lines, anchors, chains, tackle, &c. The barge J. W. Vansant, originally intended for a hospital boat, has never been completed, and has been used as a storage boat for the tents, disinfectants, and other stores owned by the board. The cabin has never been inclosed, which leaves the stores exposed to the dampness during the winter season, and much damage would be done by a driving rain. The roof is insecure, and a heavy snow would crush it in. The superintendent desires to direct attention to this craft, and suggests that Captain Caldwell be consulted by your committee as to the best plan of making the necessary repairs, which he can fully explain.

PUBLIC CONFIDENCE IN THE SERVICE.

With a few unimportant exceptions, the press and the public generally of the whole valley have given their undivided support to the service and encouraged its work. In the early summer several rumors were easily proven to be groundless, and an official denial of such rumors by representatives of the National Board again restored confidence without the least interruption to passenger travel or commercial interests. The prompt notification through the public press of a case of yellow fever from Havana in New Orleans (Forbes's case) gave assurance that points of danger were guarded with vigilance, and that all precautions would be intelligently employed to prevent its getting a foothold in New Orleans, and thence endanger the valley. The appearance of subsequent cases directly traceable to this imported one created less uneasiness than was anticipated, which the Board can flatter itself was due to the measures so promptly used to suppress its spread. The civil authorities in the region directly under the supervision of this service have given all possible encouragement and aid to the officials in charge, imposing penalties for violations of regulations, as instanced in the fining of the owners of the two boats, the Night Hawk and Vanderburg, by Memphis municipal authorities. These are the first instances in my knowledge where the rules were deliberately disregarded and the penalty promptly imposed. The service is under obligations to the steamboat officials for courtesies, their thoughtfulness and kindness contributing to the comfort of inspectors and their employés at the stations. The superintendent feels it a duty and pleasure to commend the fidelity and usefulness of Capt. Thos. Caldwell to the Board, and to state that he displays wisdom in the care of the Board's effects and exercises rigid economy in his expenditures. The superintendent and other members of the service feel under obligations to Dr. R. W. Mitchell for his personal interest in their welfare and for his counsel and assistance, which has materially lightened their labors and responsibilities.

I have the honor to be, very respectfully, your obedient servant,

FAYETTE DUNLAP, M. D.,
Superintendent River Inspection Service, Memphis, Tenn.

Dr. CH. SMART, *U. S. A.*,
Secretary National Board of Health, Washington, D. C.

APPENDIX L.

ANNUAL REPORT FOR 1882 OF STANFORD E. CHAILLÉ, M. D., SUPERVISING INSPECTOR NATIONAL BOARD OF HEALTH AT NEW ORLEANS, LA.

OFFICE OF THE SUPERVISING INSPECTOR AT NEW ORLEANS
OF THE NATIONAL BOARD OF HEALTH,
New Orleans, La., October 3, 1882.

Dr. CH. SMART,
Secretary National Board of Health:

SIR: Assigned to duty on April 1, I have been at my post continually, except from May 18 to 24. During this week I, in compliance with instructions, accompanied Dr. Bemiss, the local member of the National Board of Health, on a tour of inspection of the Ship Island quarantine station and of the coast of the State of Mississippi. The boards of health of the three coast counties—Hancock, Harrison, and Jackson—were interviewed, and the same cordial co-operation between these boards and the National Board of Health in 1881 was secured for 1882.

In addition to the co-operation with these boards, the proclamations of the governors of Mississippi and Texas, and the resolutions of and correspondence with the Mississippi and Tennessee State boards of health, the municipal boards of Memphis, Mobile, and Galveston, and the health officers of Alabama and Texas, all furnish abundant evidence of their desire, in 1882, to co-operate with and of their confidence in the National Board of Health and its inspection service. The board of health of the State of Louisiana is the only sanitary authority which has expressed lack of confidence in and unwillingness to co-operate with the National Board of Health. The history and causes thereof will now be stated.

I.—THE NATIONAL AND THE LOUISIANA STATE BOARDS OF HEALTH IN 1882.

I was directed to be guided by my general instructions of April 28, 1881, as published in Appendix 4, Supplement No. 15, Bulletin National Board of Health. These instructions, which were in accord with the resolutions of various boards of health and of the sanitary council of the Mississippi Valley (which council is composed chiefly of sanitary officers), solicited from the authorities of Louisiana their co-operation in three measures, which have caused all of the dissension between the Louisiana State and the National Boards. These three measures are as follows:

(*a*) Refusal to permit infected vessels to enter the Mississippi River until a certificate of disinfection should be presented from the quarantine refuge station at Ship Island.

(*b*) Permission to assign to duty at the Mississippi quarantine station an inspector of the National Board of Health as a sentinel to give warning of any danger of infection observable at this most important outpost.

(*c*) The assurances of the State board that it would promptly furnish the agent and representative at New Orleans of the National Board of Health (myself) full information not only of all cases of yellow fever, but also of all suspicious cases of fever, to the end that the inspection certificates should be trustworthy and that everything possible to do should be done to protect the health and commerce of all the States.

The first measure was rejected by the State board in 1882, as in 1880 and in 1881. The second measure met with marked disapproval, but having been referred to the governor of Louisiana by the State board as outside of its jurisdiction, his excellency had the permission first solicited in 1881. Of the three measures, only the third was accepted by the State board.

Inasmuch as the National Board was most anxious to avoid the misunderstandings which had been so frequent since the accession, in April 1880, of Dr. Joseph Jones to the presidency of the State board, it was deemed prudent respectfully to inquire of the authorities of Louisiana what co-operation in 1882 could be expected in reference to the above three measures. As it was desired that the inspection service should be established by May 1, inquiries were promptly made and prompt answers were hoped for.

INSPECTOR NATIONAL BOARD OF HEALTH AT THE MISSISSIPPI RIVER QUARANTINE STATION.

The satisfactory reply of his excellency, the governor of Louisiana, was as follows:

EXECUTIVE DEPARTMENT, STATE OF LOUISIANA,
Baton Rouge, April 15, 1882.

Dr. STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health, New Orleans, La.

DEAR SIR: I have received your letter of April 4, inquiring whether the privilege of stationing an inspector of the National Board of Health at our [Mississippi River] quarantine station would be continued. I would respectfully state that the permission as given by Governor Wiltz for the residence of an inspector of the National Board at the quarantine station has not been revoked. It is expected that the inspector residing there shall subject himself to the regulations of the State board of health. In accordance with the intention of the act of Congress the National Board is to assist the State board, and there is no necessity for a conflict of authority. The resident physician of the National Board is therefore expected to aid and assist the quarantine physician of the State board of health, and it is not the intention, in continuing this order of the late governor, that he shall supervise, control or direct the actions of the quarantine physician, or in any way interfere with the duties imposed upon him by the laws of Louisiana.

Very respectfully, yours,

S. G. McENERY,
Governor.

Acknowledging on April 18 receipt of the above favor, I gave the following assurance:

"There is not the least desire to abuse this privilege. In evidence thereof, a copy of the official instructions, issued last year to said inspector, is inclosed, and if other instructions should be issued this year a copy will be promptly forwarded, in the hope that the National Board may be duly notified should your excellency consider that any of its instructions tend to violate the conditions on which said privilege has been granted."

Since his excellency Governor McEnery has indicated no dissatisfaction with these instructions, and since no one has manifested any dissatisfaction with their execution, it is presumed that in this matter the State authorities have not been dissatisfied with the National Board.

REPRESENTATIVE OF THE NATIONAL BOARD OF HEALTH, TO WHOM ALL CASES AND SUSPECTED CASES OF YELLOW FEVER SHOULD BE REPORTED BY THE STATE BOARD.

In regard to the third measure advocated by the National Board of Health, the following correspondence took place. However, before presenting this, it is well to note that the regular meetings of the State board are weekly from June to November and monthly in other months, and that the first letter was written with the presumtpion that it would be acted upon at the next regular meeting on April 13, or at a special meeting certainly not later than the end of the month.

NATIONAL BOARD OF HEALTH,
New Orleans, April 3, 1882.

Prof. JOS. JONES, M. D.,
President Louisiana State Board of Health:

DEAR SIR: For the information and consideration of the State board of health, I respectfully submit the following:

I have received official notice that on April 1, 1882, I was assigned to duty by the National Board of Health as its "representative and chief executive agent, in New Orleans," with the title of supervising inspector National Board of Health. I am directed to be guided by the same instructions given me "April 28, 1881," copies of which were furnished your board, but will be again supplied if requested. It therefore becomes my duty again to solicit attention to the paragraph in said instructions, which refers to the Eadsport and Ship Island question as a means to promote the policy "considered highly desirable by the National Board of Heath, that infected ships should be, as far as possible, excluded from the Mississippi River."

In order to avoid misunderstandings, I am also directed to inquire whether the various resolutions heretofore adopted and the privileges granted by your board, in respect to the National Board and its officers, are still in force and likely to be continued in

force during the present year; and also whether the mutual promises given by the president of the State board on the one hand and by the "representative" of the National Board on the other, respecting the prompt interchange of all information in regard to any cases or suspected cases of yellow fever are to hold good for the present year, the same as for the year they were made specially to apply to?

It is very desirable for the efficient discharge of my duties that I should receive information on the subjects above referred to, at the earliest convenience of your board. Should the replies be favorable, it is my present intention to assign to duty on May 1, or thereafter, the same officers who were in service last year, none of whom were objected to by your board.

Very respectfully, yours,

STANFORD E. CHAILLÉ,
Supervising Inspector, National Board of Health.

OFFICE BOARD OF HEALTH, STATE HOUSE, STATE OF LOUISIANA,
New Orleans, April 4, 1882.

Prof. STANFORD E. CHAILLÉ, M. D.,
Supervising Inspector, National Board of Health:

DEAR SIR: In reply to the communication of the supervising inspector of the Natinoal Board of Health, of the 3d instant, his attention is respectfully directed to act 80 "to reorganize and render more efficient the board of health of the State of Louisiana," approved April 20, 1877, sec. 2.

Under this act the board of health will proceed to effect its organization at the next regular meeting, which will be held during the next ten days.

As five new members will then take their seats, and as all the officers will be elected and the various committees appointed, it is impossible for the undersigned to answer specifically and definitely the inquiries of the supervising inspector of the National Board of Health.

In accordance with the request of the supervising inspector of the National Board of Health, two copies of the annual report of the State board of health are furnished.

Respectfully,

JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana.

NATIONAL BOARD OF HEALTH.
New Orleans, April 19, 1882.

Prof. JOSEPH JONES, M. D.,
President Louisiana, State Board of Health:

DEAR SIR: Referring to my communication of April 3, and to your reply of April 4, I beg leave respectfully to state that an answer to mine of the 3d is very desirable at as early a date as may be practicable. Inasmuch it as is expected to recommence the inspection service of the National Board of Health on or about May 1, some days of preliminary preparation are indispensable therefor, and I should hesitate to take necessary action until the answer of State board is received.

I beg leave to inform you that in an official communication, dated April 15, 1882, Governor McEnery has continued to the National Board of Health the privilege of stationing one of its inspectors at the Mississippi River quarantine station.

Yours, very respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector, National Board of Health.

OFFICE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, April 20, 1882.

Prof. STANFORD E. CHAILLÉ, M. D.,
Supervising Inspector, National Board of Health, New Orleans, La.:

SIR: In reply to the communication of the supervising inspector of the National Board of Health of the 19th instant, I will state that the board of health of the State of Louisiana was formally placed in possession of his letter of the 3d instant at the regular meeting on the 13th instant, but no action was taken thereon.

The next regular meeting of the board of health will be held on the 11th of May. In accordance with the resolution of the board of health, unanimously passed after its organization, the president was authorized and empowered to arrange and appoint the standing committees, and amongst the number I have appointed and commissioned a "conference committee," composed of five members (a majority of the board), and I regard this body of eminent medical and mercantile gentlemen and sanitarians as fully competent to discuss the official communications of National and State boards of health in the interim between the regular meeting of the board of health prescribed by the organic acts of the legislature. If, therefore, the supervising inspector will

place in the hands of the president of the board of health of the State of Louisiana certified copies of the following documents:

(*a*) Official communications of the National Board of Health relating to the organic acts of the legislature and the legal quarantine and health authorities of Louisiana.

(*b*) "Official communication dated April 15, 1882," of "Governor McEnery," which "has continued to the National Board of Health the privilege of stationing one of its inspectors at the Mississippi River quarantine station."

(*c*) Names of quarantine inspectors proposed by National Board of Health for duty in Louisiana.

Upon the receipt of the above data these papers, as well as the letters of the supervising inspector, National Board of Health, of the 3d and 19th instant, will be placed in the hands of the conference committee for discussion and consideration, and such reply will be furnished as the honorable members of this committee may deem appropriate to meet the official communications of the National Board of Health, in accordance with the quarantine and sanitary laws of Louisiana.

Respectfully,

[SEAL.]

JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana.

NATIONAL BOARD OF HEALTH,
New Orleans, April 21, 1882.

Prof. JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana:

SIR: To yours of April 20, making an answer to my communication of April 3, contingent upon my placing in your hands certain documents, &c., specified by letters, I reply:

In regard to (*a*), I have received from the National Board no such communications bearing in any wise on the questions propounded in my letter of April 3 other than those furnished the State board last year; in regard to (*b*), a copy is inclosed; and in regard to (*c*), the only quarantine inspector thus far proposed is Dr. G. F. Patton, who served last year, and for whom both Dr. Finney and yourself expressed a preference.

Respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector, National Board of Health.

OFFICE BOARD OF HEALTH, STATE HOUSE, STATE OF LOUISIANA,
New Orleans, April 21, 1882.

Prof. STANFORD E. CHAILLÉ, M. D.,
Supervising Inspector, National Board of Health:

SIR: The communication of the supervising inspector of the National Board of Health of this instant has been received and will be referred to the "conference committee" of the board of health of the State of Louisiana, with the request that prompt and decisive action be taken.

Respectfully,

[SEAL.]

JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana.

As a result of the continued delay of the State board to take any action upon the application made in my letter of April 3, the following preamble and resolution were adopted, May 1, conjointly by the sanitary and by the medical and surgical associations of New Orleans:

"Whereas the health authorities of the States of the Mississippi Valley have requested that the inspection service of the National Board of Health in Louisiana, as operated last year, be re-established on May 1; and

"Whereas no action has as yet been taken by the board of health of the State of Louisiana in relation thereto:

"*Resolved*, That the president of the board of health of the State of Louisiana be respectfully requested to call a special meeting of said board at the earliest possible date for the purpose of renewing the same relations with the National Board as existed in 1881."

Notwithstanding these and other efforts to induce the State board to take action on the application of April 3, no action was taken until the regular monthly meeting, on May 11, when the following resolutions, presented by the conference committee of the State board, to which the president had referred the above and all other communications on the subject, were adopted:

"In matter of the friendly relations subsisting between the State and National boards of health.

"1. *Resolved*, That the opinions, invitations, and agreements of the board of health

of the State of Louisiana remain the same as last year; and the National Board of Health may continue to depend upon the adherence of this board to its pledges of industry, promptness, and candor in all affairs affecting the health of the people of the Mississippi Valley, particularly the exclusion by a quarantine at once sensible and rigid of foreign pestilence.

"2. *Resolved*, That this board conceives the present an opportune moment to state that, in its opinion, communications on important questions involving quarantine or other matters, making it necessary for the National Board of Health to inform or consult with this board, should be made by or through the president or secretary of said board, and not by its agents or employés; and hereafter this board will not feel itself bound to recognize as official, or to take action upon, communications of the character above described, unless they shall come from or through the president or secretary of the National Board to the president or secretary of this State board.

"3. *Resolved*, That the president is hereby requested to convey to the Hon. J. L. Cabell, president of the National Board of Health, the substance of the foregoing paper and resolutions, with such additional remarks in explanation or of suggestion, as he may think proper to make."

These resolutions of May 11 complied with the instructions of the president of the State board to its conference committee. In said communication of April 21 he stated: "It is evident that the supervising inspector, National Board of Health, has nothing new to communicate, and that he simply reiterates the propositions finally settled in 1881 by the board of health, State of Louisiana. Instructions to its agents and employés, inspectors and supervising inspectors, by the National Board of Health, should not be entertained as official communications to the board of health, State of Louisiana. If the National Board of Health desires to communicate its views about quarantine and sanitary matters, it should do so directly through its recognized head, the president, or through the secretary, who is also a member of said board. All discussions of the duties and labors of the board of health, State of Louisiana, by the agents and employés of the National Board of Health, are out of order."

In regard to these views and to their result, the above resolution "2," the following facts deserve consideration. From April 28, 1881, the date of my designation by the National Board of Health as its "representative and chief executive agent in New Orleans," with the title of supervising inspector, to April 21, 1882, the State board received and replied, without objection, to my communications as the "representative" of the National Board of Health. On April 15, 1882, his excellency, the governor of Louisiana, did me the honor of communicating with me as the representative of the National Board of Health, although his appointee, the president of the State board, advised, on April 21, that no such honor should be paid me by his board, apparently because beneath its dignity. In 1879 I represented the National Board in Cuba, and, inasmuch as during my sojourn there, all of its authorities, from the governor-general down to the weakest municipal board of health, welcomed official communication with myself, as the representative of the National Board, I had reason for astonishment that the courtesy extended in a foreign land should be denied to the National Board in my own city and State. Farther, whoever appreciates how indispensable is promptness in combating pestilence, will comprehend how dangerous and impracticable dilatory communications between New Orleans and Washington would become when an epidemic was threatened or at hand; that is, at the very times when the services of the National Board would be of greatest moment.

The change of policy, expressed in resolution "2," is presumed to have been due to two causes. In the first place, the president of the State board, in a communication of April 17 to Governor McEnery, indicated his decided disapproval of the method pursued by the National Board of Health to secure the continuance of its inspector at the quarantine station. He wrote as follows: "In such important questions relating to a quarantine as those involved in the letter of the supervising inspector [to the governor on April 4], the National Board of Health should communicate with the executives and boards of health of the sovereign States, through and by the president of the National Board of Health, and not through the agents or employés of said board." However, the governor himself had not apparently adopted any such view, and in 1881 the whole subject had been referred to the governor by the State board, for the alleged reason that it was "without power" to act.

In the second place, the State board, and especially its president, have manifested, from early in 1880 to the present time, such incessant hostility to the National Board of Health, that their official reports and the local newspapers have been made constant vehicles for misrepresentations, calculated to incite public prejudice and odium. Since the success of sanitary and all public measures depend ultimately on the will of the people, I have deemed it a duty to strive to correct the grossest of these misrepresentations. In the discharge of this duty, I have been several times forced, much against my will, to defend the National Board of Health in the same public press which the State board used for its unjust accusations. Fully alive to the discredit attaching to a newspaper warfare between official bodies dedicated to the philan-

thropic and noble cause of public health, I have never published a word except in reply to false accusations against the National Board, and have at times maintained silence even when filled with indignation by ingenious misrepresentations. The last annual report of the State board, for 1881, was distributed about the first week of April, 1882, and contained more than 70 pages of records relating to the National Board of Health. On April 14 I addressed Governor McEnery in reference to this annual report, which was also addressed to his excellency, a letter which was published on April 23, and in which I attempted to prove that the official report to the governor and general assembly of Louisiana, of the president of the State board, contained numerous statements in regard to the National Board of Health which were "*inaccurate, partial,* and *misleading.*"* Any failure to establish what was attempted was due to the writer's inability and not to his lack of evidence. This and several similar efforts to correct official misrepresentation were, no doubt, displeasing to those who preferred that the public should be taught only one side of a question, and strengthened the determination of the State board to adopt resolution "2."

My instructions from the National Board of Health in reference to said resolution were to "go on and perform your duty as heretofore, and, in case it becomes proper to notify the health authorities of Louisiana of any danger to the public health, present or prospective, you will do so in accordance with your previous instructions."

DISCHARGE OF CARGO OF AN INFECTED VESSEL INDISPENSABLE TO ITS DISINFECTION.

Special inquiry having been made by the health officer of Alabama in regard to the discharging of cargo at the Louisiana quarantines as a means to the thorough disinfection of vessels, I investigated the matter, and finding that this was not and had never been habitually practiced, I deemed it my duty "to notify the health authorities of Louisiana of this danger to the public health both present and prospective." On this subject the following correspondence ensued:

NATIONAL BOARD OF HEALTH,
New Orleans, June 28, 1882.

Prof. JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana:

SIR: In behalf of the National Board, and as the representative of the sanitary interests of other States than Louisiana, I deem it an imperative duty to solicit the attention of the board of health of the State of Louisiana to the following:

The length of time a suspected vessel may be detained at quarantine is deemed of importance secondary to the thoroughness of disinfection, and to accomplish this the discharge of cargo is indispensable. I was informed, on June 26th, that this is not being enforced at the Mississippi River quarantine station. The continuance of this alleged omission will cause grave dissatisfaction in other States.

On June 26 I verbally proffered sanitary inspectors and policemen of the National Board of Health to report at once to yourself, in order to aid and co-operate with the State board in measures of isolation and disinfection, in connection with the case of yellow fever from the S. S. Marco-Aurelio [the first case in 1882], and I now solicit special attention to the following paragraph in my instructions, still in force, of April 28, 1881: "In case yellow fever appears in the city of New Orleans during the summer, it is the desire of the National Board to co-operate in every way with the health authorities of the city to restrict the spread of the disease and to stamp it out if possible, and to this end it will be prepared to pay for such services and materials as are necessary for this purpose."

Yours, respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

OFFICE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, La., June 29, 1882.

Prof. STANFORD E. CHAILLÉ, M. D.,
Supervising Inspector, National Board of Health, New Orleans, La.:

DEAR SIR: Your communication of yesterday to Dr. Joseph Jones, president board of health, State of Louisiana, has been referred to the conference committee. Will you please inform me what vessels, arriving at the Mississippi quarantine station, have not been detained or quarantined full time and thoroughly disinfected?

Your offer on behalf of the National Board of Health is fully appreciated; thus far the State board of health has been fully able and competent, and have been and are doing all that is possible to be done to restrict the spread of the disease and stamp it out.

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* Printed copies of my letter accompany this report.

I have sent a copy of your communication to Dr. James F. Finney, officer at Mississippi quarantine station.

Very respectfully,

[L. S.] A. W. BOSWORTH,
Chairman Conference Committee, Board of Health, State of Louisiana.

NATIONAL BOARD OF HEALTH,
New Orleans, June 29, 1882.

Col. A. W. BOSWORTH,
Chairman Conference Committee, Board of Health, State of Louisiana:

DEAR SIR: My communication of 28th does not allege that vessels have "not been detained or quarantined full time," nor that they have not been as "thoroughly disinfected" as they can be without discharge of cargo. It does allege that my information is that cargoes are not discharged, and I concur with all sanitarians in the opinion that vessels cannot be thoroughly disinfected unless their cargoes be discharged. This view is also forcibly advocated by Prof. Joseph Jones, M. D., on p. 616, February No., 1869, of the New Orleans Medical and Surgical Journal.*

Yours, very respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

Two results, apparently, of this correspondence were published in the proceedings of the two next meetings of the State board, and were as follows:

First. At the meeting of June 29 the following resolutions were introduced:

"*Resolved*, That a strict system of quarantine, consisting in discharging the cargo of vessels, in order to more thoroughly ventilate, disinfect, and purify the ship, its cargo, and merchandise, its crew, passengers, and baggage, be rigidly enforced during the term of full ten days (240 hours), from the time of arrival at the Mississippi quarantine, against all vessels from ports included in the governor's amended quarantine proclamation of June, 1882, and from ports that may hereafter be declared infected.

"*Resolved furthermore*, That the quarantine physician be instructed to report to this State board of health, at the expiration of said ten days' detention, the exact sanitary condition of each vessel before her arrival and during her sojourn at the quarantine station.

"In view of the importance of these resolutions action thereon was postponed until the next regular weekly meeting."

The newspaper, which has always been the strongest partisan of the president of the State board, thus commented on these proposed resolutions, which it is believed were never adopted: "The entire unloading of infected vessels, or of those which there are good grounds to suspect of infection, seems to an outside observer essential to guard against the introduction of fever into our city. If we are trying quarantine fairly and squarely, let it be tried with all its accompaniments and with full guarantee. Let each and every sanitary precaution be taken in that line, and all will abide by the result."

Second. At the next meeting, July 6, the only published reference to this subject is as follows:

"Dr. Jones read a telegram which he had sent to Dr. Finney, the resident physician at the Mississippi quarantine station, directing that the cargo of sugar of the schooner H. N. Hauge, from Havana, be unloaded and thoroughly disinfected, and the vessel fumigated. Dr. Finney was instructed to *act similarly* in the future in all cases where vessels arrived with cargoes loaded at infected ports. Vessels simply touching at these ports to deposit the mail and receive passengers would be quarantined ten days, but if arriving with clear bills of health their cargoes, when laden at ports where no disease of an infectious or contagious nature existed, would not be taken from the vessel."

It deserves notice that the majority of vessels from infected ports arrive in ballast.

Additional evidence, respecting the discharge of cargo for purposes of disinfection, was reported September 22, 1882, by the inspector of the National Board of Health, at the Mississippi River quarantine station, as follows:

"The Norwegian bark Cato, from Rio de Janeiro, with a cargo of 7,000 bags of coffee, which arrived here September 15, after having suffered considerable damage to vessel and cargo during the hurricane of the 9th instant, has just finished discharging her coffee into a large grain barge, where it will be thoroughly fumigated. The work has been done by the same stevedore and gang of acclimated (negro) laborers who have been previously engaged on similar work at this station. I am gratified to see the idea advocated in my reports of last year thus *partially* carried into execution, and can say that I believe the advantage of such a plan has been impressed upon all interested, the parties who have witnessed the transfer of this cargo."

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* See the same also on p. 118 Annual Report for 1881 of board of health, State of Louisiana.

PROPOSED SUSPENSION OF THE INSPECTION SERVICE, NATIONAL BOARD OF HEALTH.

The failure of Congress to make any appropriation to the National Board prior to July 1 for the fiscal year beginning with that date, and the refusal of the House of Representatives, a few days thereafter, to appropriate funds sufficient for the inspection service, caused the issue by telegram of a precautionary notice that the officers of the National Board of Health should make preparation to close the service on July 15. This telegram of the National Board of Health was simply a brief official order, and wholly inoffensive. It reached the press of New Orleans via Memphis, where the agent of the Associated Press attached to the telegram his own comment thereon, a comment justly offensive if made by the National Board of Health. As the telegraph does not punctuate, the telegram of the National Board of Health, with the comment of the newspaper agent added thereto, was delivered to the Associated Press without marks of quotation separating the former from the latter. However, the intelligence of the press throughout the country was generally equal to the occasion, and the quotation marks were correctly supplied. On July 10 our two chief daily newspapers—the Times-Democrat and the Picayune—published telegram and comment, the former correctly, while the latter supplied quotation marks in such wise that the offensive comment was represented as a part of the official telegram. Promptly on the 10th I called the attention of the Picayune to the injurious error committed by it but not committed by the Times-Democrat. About 1 p. m. on the 13th, not having until then received an authoritative official denial that the comment was no part of the official telegram, I addressed an official note to the Picayune giving it absolute assurance of that fact. No notice whatever was taken until July 18 of my corrections of the 10th and 13th of the error committed, and in the mean time public prejudice was greatly incited against the National Board of Health by means of this gross misrepresentation.

Such had been and was the animus of the State board, that it rejected the authority of the Times-Democrat, that it neglected to apply for correct information to the National Board of Health or to any one authorized to give it, and that it hastened to credit the false and injurious telegram to the Picayune of the 10th in spite of the fact that its trusted authority had been made aware of its falsehood and injustice on both the 10th and 13th. The published proceedings of the State board at its regular meeting, 7½ p. m., July 13, record the following extraordinary action taken by it in this matter:

"Whereas an effort is being made to have it appear that the health of the people of New Orleans, of Louisiana, and of the Mississippi Valley is being jeopardized by the Congress of the United States in refusing to continue the appropriation for the salaries of the official staff of the National Board of Health; and whereas Dr. T. J. Turner, secretary of said National Board of Health, has caused to be circulated (it is supposed) by order of said Board, a scandalous telegram as below, to say:

"'MEMPHIS, *July* 9.—Dr. R. W. Mitchell, resident member of the National Board of Health, this morning received the following telegram from Dr. T. J. Turner, secretary of the National Board of Health at Washington:

"'Give notice to all concerned to be prepared to close inspections on the 15th instant, and get all Government property ready to place out of commission. Notify the valley.* This action is owing to Congress failing to make an appropriation, and, in the event of an outbreak of fever along the coast remands the residents of the Mississippi Valley, to such protection as can be given by the State and local boards of health and the trusty shot gun.'

"This alleged notification, as aforesaid, intended as a libel upon this and other State boards of health, and, by thus defaming them, to bulldoze the Congress of the United States into granting said National Board of Health their accustomed moneys and salaries; and,

"Whereas, said National Board of Health, by the emission of such innuendoes and incendiary publications, violates the conventionalities of official intercourse in a gross and unwarrantable manner, showing what it would do if it once had power, and reflecting most aristocratically upon the self-governing ability of the American people: Therefore, be it

"*Resolved*, That the telegram of Secretary Turner be copied and forwarded to President Cabell, of the National Board of Health, with the request that in future—if the Board has any futrue—their communications to the people of the valley be couched in more decorous language when alluding to this board.

"*Resolved*, That this State board, supported by the confidence of the people, will continue its efforts, with aid from State, city, and volunteers, to ward off the importation of foreign pestilence, and trust that, with the help of a beneficient Providence guiding the skill and courage of man, the health of the valley may be preserved without recourse to the 'trusty shot-gun,' recommended by the National Board of Health."

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* The official telegram ended with *valley*, after which word other papers than the Picayune correctly attached quotation marks.

Although a correction of the error and injustice committed was published over my official signature on both the 15th and 18th of July, yet the State board, which had impatiently hastened to accept and indorse the error and injustice of the Picayune, very patiently awaited for the formal denial of the president of the National Board of Health, and until July 27, before it ventured to make any admission of the wrong done, by adopting the following:

"*Resolved*, That, considering the disavowal by the National Board of the objectionable portion of the Turner telegram of July 9, this board withdraws all that part of its preambles and resolutions of July 13 which stands affected by such disavowal."

However, the wrong done had sufficed to foment popular prejudice, which was extended and itensified by at least five additional causes, which gave rise to the publication of persistent misrepresentations very injurious to the National Board of Health. These five causes were: First, the publication on July 14 of four "personal and confidential" letters from members of the National of Board Health; second, the publication on July 19 of renewed and thereafter oft-repeated charges that the National Board of Health was striving to manufacture cases of yellow fever; third, the uncertain action of the National Board of Health as to the continuance of the inspection service; fourth, the action of the Mississippi State board of health in demanding an inspection of passengers; and fifth, various misrepresentations as to the expenditures, &c., of the National Board of Health.

ADDITIONAL MISREPRESENTATIONS OF THE NATIONAL BOARD BY THE STATE BOARD.

If injustice and misrepresentation deserve correction, then these subjects must be considered at sufficient length for their comprehension.

The injustifiable and prejudicial resolutions of the State board, July 13, were published on the 14th. On the same day the Picayune published four "personal and confidental" letters to Dr. Beniss, the local member of the National Board of Health, from four of his colleagues. Whoever will compare these letters with pp. 412–14 of the annual report Louisiana State board for 1881 will be convinced that as early at least as August 3, 1881, one or more members of the State board had access to these "personal and confidential" letters. By what honorable means their possession was secured it is impossible to conjecture.

Covering the time, July 12 to October 1, these letters prove no more than the anxiety of the authors to learn the whole truth as to the reported existence of yellow fever in Plaquemine Parish, Louisiana, and their determination not to permit an unpopular minority to have its opinion, if well founded, overrun by a majority which was clamorously sustained by popular prejudice. The State board and popular prejudice had, at the time, unsparingly denounced the minority, declaring that its purpose was to "manufacture yellow fever." However grossly unjust was this accusation, the press sustained it, refused to publish the opposing facts, and thus induced the public to credit it. Hence, when the Picayune published these letters on July 14, 1882, and claimed that they proved "*a plot to work up yellow fever cases in* 1880," other newspapers, repeating the accusation, revived the popular prejudice and prepared the public blindly to credit the National Board of Health with any similar plot in the present or future. The ignorant and inexperienced in such matters may better comprehend how readily popular prejudice can be aroused on this subject by reflecting on the following fact: Not one instance is known to me wherein doctors have disagreed as to the diagnosis of yellow fever, that popular prejudice has not always favored those who denied such diagnosis. This prejudice will continue until health interests are as well appreciated by the people as their money interests are now appreciated. The magnitude of the prejudice aroused in New Orleans on July 14 is indicated to some extent by the fact that, while no honorable man can countenance the possession, much less the publication, of the "personal and confidential" letters of another, and while numerous comments thereon were published, yet the natural indignation against this outrage was so much subordinated to prejudice, that not one word of protest has ever been published against the outrage.

As I had had nothing to do with the alleged yellow fever of 1880, nor with the telegram of July 9, 1882, my official acts had thus far escaped denunciation. But our first case of yellow fever had died on June 26, and the publications of July 14 were well calculated to direct public prejudice towards myself. Sense of duty promptly forced me to face it. On July 17 Dœschler died. Nine physicians, among whom there were five State officers, and myself as the representative of the of the National Board of Health, believed that his death was due to yellow fever, while the president of the State board and one other physician attributed his death to a remarkable combination of jaundice, gastro-duodenitis, intemperance, albuminuria, and malarial fever. The greatest prominence was given by the press to the latter view, while the unfavorable opinion and facts of the nine physicians were so underrated and suppressed that it would be surprising if popular prejudice had not credited the publication of Dœschler's death as "a pronounced case of *alcoholism* and *jaundice*, which gave

rise to unfounded rumors of yellow fever." Falsifiers were not lacking to attribute these rumors to myself and to the desire of the National Board of Health to initiate another "plot to work up yellow fever cases" in 1882. This vile charge was repeated even in Congress, and was again and again renewed in New Orleans. The subject is of such moment that a full statement of all the facts will be subsequently made.

The increasing prejudice, aroused by the three causes now considered, was intensified by the uncertain and dilatory action of the National Board of Health as to the continuance of its inspection service. I was ordered, July 9, to *be ready to close* on the 15th; on the 15th I was instructed to await further orders; on August 8 I was instructed to continue until further orders; and finally it was not until August 22 that I was assured the inspection service would be continued throughout the season. The explanation of this uncertainty and delay was simple. The uncertain, dilatory, and unfavorable action of Congress was alone responsible for the action of the National Board. However, the public of New Orleans was taught to attach the blame to the National Board of Health and to attribute its action to petty and unworthy motives. The prejudice thus aroused was greatly strengthened by the action on July 12, of the Memphis board of health, which decided that very injurious quarantine restrictions should be imposed on the commerce of New Orleans in case the inspection service of the National Board of Health should be closed.* The Louisiana State board and several commercial bodies vehemently protested against this action, and the public was falsely taught that the Memphis board had been prompted to act by the National Board of Health in order to prove to Congress the importance of said board to the commerce of the country, and thereby to force Congress to support the National Board. The previous warnings of Memphis had been denounced as threats, and seemed to have been forgotten, as also were forgotten the action and in some instances the warnings of the sanitary council of the Mississippi Valley, the State boards of Michigan, Illinois, Tennessee, and Mississippi, and of the health authorities of Texas and Alabama. The demands of others on New Orleans for the inspection service of the National Board of Health were attributed to the malign influence of said board in undermining confidence in New Orleans and in its board of health, although history abundantly proves that equal or greater lack of confidence prevailed prior to the origin, in 1879, of the National Board.

Another cause for public dissatisfaction and prejudice was found in the fact that early in August the Mississippi State board began its efforts, which were not successful until September 6, to have the National Board appoint inspectors for the purpose of giving health certificates to all passengers from New Orleans who intended to stop in Mississippi. Although the Mississippi State board had in this matter been opposed by the National Board, the latter was none the less accused of having favored it; and, when this was disproved, the National Board was still accused of having inspired the action of the Mississippi board by manufacturing cases of yellow fever, and by thus alarming this board. The facts can be better appreciated after the consideration which will be given to this last accusation.

The sixth and last means by which popular prejudice was continually excited against the National Board, was the publication of half-truths mixed up sometimes with ingenious and at other times with gross misrepresentations. The record of all these would greatly lengthen this report. It is hoped that the notice given to those misrepresentations which inflicted the most injury will suffice to illustrate the nature of all of them.

YELLOW FEVER IN NEW ORLEANS IN 1882 AND ITS ALLEGED MANUFACTURE BY THE NATIONAL BOARD OF HEALTH.

Before recording the essential facts in this matter, attention is called to the four following considerations: It is notorious to all physicians having experience in either the practice or the literature of yellow fever, that medical science continues to be incompetent to diagnose many cases of yellow fever, and, therefore, that doubt and suspicion are unavoidable. Hence, it is as requisite that the sanitary officer should apply preventive and protective measures to cases suspected as to those known to be cases of yellow fever. In order better to avoid disagreement between doctors, and better to determine what should constitute reasonable suspicion, a schedule of symptoms, &c., was early in 1881 indorsed with great unanimity by the Louisiana State Medical Society, and by the only two medical societies of New Orleans; and the schedule, thus indorsed, was authorized by the National Board of Health (see p. 15, D, Appendix 4, Supplement No. 15, Bulletin National Board of Health), and thereby became the official guide which has in every case rigidly controlled my reports.

In the second place, bound by oath, honor, and conviction to obey orders, I was instructed to report every case of yellow fever and every "doubtful or suspicious" case to the Secretary and to the Superintendent of river inspections, National Board

* Vicksburg, on July 11, demanded, for the same reason, prompt protection of its State board.

of Health, and to those "health authorities of other States and municipalities" who might call on me for such information. With copies of these instructions in their possession, the hospitals, the medical societies, and nearly one-half of the reputable physicians of New Orleans promised, in 1881 and in 1882, and the Louisiana State board pledged itself by formal resolutions in both years, to report to me promptly all such cases as my instructions compelled me to report.

In the third place, neither the National Board of Health nor any member thereof ever gave any instructions or ever made any suggestions in reference to my reports of cases or suspicious cases, other than my official published instructions contain. Therefore, I and I alone am solely responsible for any alleged plot by the National Board of Health to work up or to manufacture cases of yellow fever in 1882. Any such plot must have been both executed and designed by me, whose family, friends, and property are all located in New Orleans, where I have been a citizen and a student of yellow fever since 1851, and since 1857 an officer in the medical department of the University of Louisiana. Whoever even hints that I lent myself in any degree to any such infamous plot is an unscrupulous falsifier.

In the last place, there had been, prior to June 26, many rumors in Memphis and other places, as well as in New Orleans, of the existence of yellow fever in the latter city. By letter and speech I did all in my power, and this was much, to end these rumors and to prove them groundless. I have abundant proofs of this, but deem it useless to present them, since no man has offered or can offer the slightest evidence to the contrary. Therefore, if any case of yellow fever was manufactured, this must have been done subsequent to June 26, on which day Forbes, an "imported" and undisputed and the first case of yellow fever, died. Further, since all the results, denounced as due to this alleged manufacture of cases of yellow fever, had been accomplished by August 12, when the Mississippi State board first demanded the inspection of passengers, it is evident that the accusation, if deserved at all, must have been specially deserved between June 26 and August 12, 1882. The reader is now prepared to appreciate the facts in this matter.

The Louisiana State board reported three cases of yellow fever; however, it recorded, in its published weekly reports, *four deaths* by yellow fever. The representative of the National Board three cases of yellow fever and three other cases as "*suspicious*," under the schedule already alluded to. The facts of interest in each of these six cases will now be given. The three undisputed cases require only brief notice.

The first case reported.—The first time that anything was said by me to justify the belief in the existence of yellow fever in New Orleans was at 2 p. m. June 26, when I reported, solely to the secretary and to the superintendent of river inspections, National Board of Health, the Forbes case, as follows: "One English sailor, arriving from Havana on the 18th, was admitted into the charity hospital with yellow fever." Several experienced physicians who inspected this case at the same time that I first did, on the morning of June 26, concurred in the opinion that this was a "*typical*" case of yellow fever, but when I stated to the president of the State board that while I should report it without qualification as simply a case of yellow fever, I would be pleased to report at the same time any opinion whatever entertained by him. He at first desired me to report, as his opinion, that the case was merely "very suspicious," but subsequently he sent me word that he concurred with my report, of which I had sent him a copy to sign, which he did not sign.

At this time I had authority to inaugurate the inspections of railroad freight whenever I might deem it necessary. As the steamship Marco Aurelio, in which Forbes came to New Orleans, appeared to be in unusually good sanitary condition, and, being in ballast, brought no freight, I declined to exercise my authority until some evidence of a tendency to spread might manifest itself. All of my influence was used to this end and to allay alarm. The National Board approved my view, but the demands of others for the aid and co-operation of the National Board of Health induced it, on June 30, to instruct me to inaugurate the inspection of freight on the two railroads which traverse Mississippi, and Kentucky. This was done on June 30, contrary to the views of the National Board of Health and of myself.

In my own behalf it may be here noted that I had the same authority as to the Louisiana and Texas Railroad in both 1881 and 1882; that I was left free by all health authorities and others to use this authority at my own discretion, and that the result of this freedom of action has been that at no time, in either 1881 or 1882, have there been inspections either of freight or passengers to Texas, nor has there been a single case of yellow fever in Texas due to New Orleans, or to my action. The policy guiding me was declared early in 1881, to the effect that I would not, as long as left free to exercise my own judgment, establish inspections except in one of two contingencies, viz, either when yellow fever in New Orleans manifested some tendency to spread, or when the States traversed by railroads should demand their inspection. However, it should not be forgotten that the experience, acquired at times when there may be no danger, by inspectors who are necessarily inexperienced, fits them very much better to encounter danger when it may appear.

Much additional evidence could be given of the desire of the National Board of Health not to interfere needlessly with commerce, and to allay groundless alarm excited by this as well as by subsequent cases; but the two following telegrams will suffice for the present. Both were made public, the latter by the Associated Press:

NATIONAL BOARD OF HEALTH,
New Orleans, June 28, 1882.

Dr. R. M. SWEARINGEN,
State Health Officer, Austin, Tex.:

There died on the 26th one case of yellow fever, imported from Havana. Diligent inquiry has failed to discover any other case in this city. All practicable sanitary precautions have been taken. Unless other cases should occur, adjacent States have no cause to fear infection from New Orleans. The publication by the newspapers of this city of the whole truth in this case should inspire confidence instead of distrust.

S. E. CHAILLÉ,
Supervising Inspector.

NEW ORLEANS, *July* 6, 1882.

Dr. TURNER,
Secretary National Board of Health, Washington, D. C.:

Please publish in the Associated Press dispatches that no case of yellow fever, and no doubtful or suspicious case has occurred since the one imported case reported on the 26th ultimo.

S. M. BEMISS,
S. E. CHAILLÉ.

The second case reported (suspicious).—This case, that of Dœschler, who died July 17, has already been referred to. It constitutes the sole specification of the vile charge that the National Board—that is, that its representative, myself—was striving to manufacture yellow fever, and if there be any proofs of this charge they should be found especially in this case. The evidence will now be presented, and attention is first called to the following official communications:

NATIONAL BOARD OF HEALTH,
New Orleans, July 18, 1882.

Prof. JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana:

SIR: I waited four hours, from 4 p. m. to 8 p. m., yesterday, for your opinion as to the cause of the death of Louis Dœschler, you having stated to me about 4 p. m. that you would send your opinion (which was not received) to my house within two or three hours.

At 8.20 p. m. I forwarded, in compliance with my instructions, a telegram to the Secretary National Board of Health, and to the superintendent river inspection service, National Board of Health; a copy thereof is inclosed. The statement in the last sentence of said telegram was made, so far as the State board is concerned, on your assurance that all sanitary precautions against yellow fever would be taken in this case, as also in all doubtful cases.

Your son, Mr. Stanhope Jones, was kind enough to show me this morning at 10 a. m. a copy of your official communication to Dr. Kelly, of Galveston. I would be obliged to you for a copy thereof.

Yours respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

My official telegram, above referred to, was as follows:

"Have witnessed *post-mortem* giving strong, though not conclusive evidence, of yellow fever. Such was the diagnosis by physicians who saw the patient, an Alsatian, about eleven years in New Orleans, admitted Charity Hospital yesterday; died this day. All precautions as against yellow fever will be taken."

It will be seen that in this case, as in every case, it was my desire to report the opinion of the State board at the same time with my own, and that in this case I was defeated by the president of said board in realizing my desire. His telegram to the president of the Galveston board of health was given great publicity, appearing on July 19 in the newspapers generally. This telegram was a very long one, attributed the death to four causes other than yellow fever, and in fact never used the words *yellow fever* except once, in order to state that Dœschler was "said to have had yellow fever." Yet Dœschler's three most intimate friends testify positively that Dœschler

had never had the disease. The report succeeded in convincing the public and the press what they greatly preferred to believe, viz, that this death was due to "*yellow jaundice*," and not to yellow fever. The belief was generally encouraged that those physicians who declared their belief that the death was due to yellow fever were influenced by ignorance or dishonesty, and were prompted by the National Board of Health. These physicians, anxious to avoid creating alarm, were loth to combat the error, and I had proofs of the unwillingness of the newspapers to publish a dispassionate statement of those facts which tended to prove that the death was in truth due to yellow fever. While proclaiming that "*the whole truth*" was being published to the world, only one side of the truth was given due but partial prominence. Thus was justice sacrificed, as it so often is, to presumed expediency.

Some of the pertinent facts on the unpopular side of this question were as follows: Five physicians saw Dœschler while sick, two of these also witnessed the *post-mortem*, and six other physicians, among whom were the president of the State board, the chairman of the board of administrators of the Charity Hospital, and myself, witnessed only the *post-mortem*. One of these eleven physicians, who had seen Dœschler only when sick and only during the first days of his sickness, concurred with the president of the State board, while all of the remaining nine attributed his death to yellow fever. Among these nine were four of the five physicians who saw the man while sick, and during the last two days of his sickness, the time when, of all others, yellow fever is best marked and most readily recognized. These four physicians had all diagnosed yellow fever before I was even informed of the existence of the case, therefore these four physicians deserve from honest men the credit, which was denounced as the manufacture of yellow fever by the National Board of Health. Three of these four worthy physicians were medical officers of Louisiana in the Charity Hospital, and the diagnosis was sustained by two other State officers—the pathologist and the chairman of the board of administrators of the Charity Hospital—both of whom had witnessed only the *post-mortem*. These five State officers had all avowed their belief that Dœschler died of yellow fever before I opened my mouth on the subject. Moreover, two of these State officers, in the discharge of official duty, signed the death certificate as by yellow fever, and the State board was forced to record and publish this death by certified yellow fever. Further, three of these State officers, as well as myself, published their reasons for the belief that Dœschler died of yellow fever—reasons which could have but little doubt in the mind of any unprejudiced medical reader.* Believing it useless to discuss such purely technical questions, the readers interested therein are referred to some 20 pages published in the August and September numbers, 1882, of the New Orleans Medical and Surgical Journal.

The consideration of all these facts is indispensable to a joint decision as to whether the representative of the National Board of Health and eight other physicians manufactured a case of yellow fever out of a case of yellow jaundice, or whether this feat was reversed by the president of the State board, aided by one other physician. The motive of the representative of the National Board of Health for his alleged attempt to manufacture yellow fever must have been, as was alleged, to create alarm, and thereby to induce a panic-stricken country to sustain the National Board of Health. If animated by a motive so despicable, is it not incomprehensible that I should have used my influence as follows: On July 20 I officially reported that "as far as myself and the officers of the National Board of Health were concerned, nothing more shall be said for the public than has been said in my official telegram, unless I should be actually forced thereto. I shall strive to leave the contest where it properly belongs—between the State officers, viz, between the president of the State board on the one side, and five officers of the Charity Hospital on the other.

"According to my official instructions Dœschler's case becomes a "*suspicious case*" for the National Board. Our cool weather, diminished mortality, and the apparent cessation of a hæmorrhagic tendency in fevers cause me to be hopeful. Unless several cases should occur between now and August 1, I shall feel confident of escape from at least a violent epidemic."

In addition, I, on July 22, addressed to the New Orleans Sanitary Associations the following remarks, which were given to the press and published widely throughout the country: "One case of undoubted yellow fever, and a second suspicious case, have caused much uneasiness. Those who are best informed know well how dangerous are predictions about this disease. None the less, I shall now venture, after thirty years' observation and study of yellow fever, to make the modest prediction that, unless several cases should occur between this date and the 1st of August, New Orleans will escape an epidemic at least.

"I base this opinion on the following facts: The summer has thus far been the coolest and pleasantest I have ever experienced here; our local sanitation, however defective, is comparatively good; the death-rate during the past two weeks has been exception-

* Published copies of my report as professor of pathological anatomy, medical department, University of Louisiana; also of the house surgeon and of the pathologist of the Charity Hospital and of the president of the State board, all accompany this report.

ally favorable; the fevers generally prevalent manifest no exceptionally evil traits; and; finally, there is no record of the occurrence in New Orleans of a violent epidemic when its outbreak has been later than August 1. At the present there is ample reason for excessive vigilance, but there is little reason for serious alarm."

Surely, from this date to August 1, was the time of all others for those who might be conspiring to manufacture yellow fever. However, the next news of yellow fever came on August 1 from the State board, and not from the maligned National Board.

In spite of such facts as have now been presented, there were men who were so vile themselves that, suspecting others of equal villainy, they accused the National Board of Health—that is myself, its representative—with the manufacture of yellow fever in order to create a panic, and thus to "bulldoze" Congress into appropriating funds for the National Board of Health to continue its inspection service, &c. That infamous accusations should find so many to give them credence, without adequate evidence, is not flattering to public morality.

The third case reported.—Of the total six cases, this was the only one of which I owe the notification to the State board of health. The following communication is also the only one I received from the same source, from the passage of the State board's resolution "2" of May 11, previously cited, to the present time.

OFFICE BOARD OF HEALTH, STATE OF LOUISIANA,
New Orleans, August 1, 1882.

Dr. STANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health:

SIR: A case of fever, Johannes Stroh, at No. 25 Enghien street, under investigation; Drs. Faget and Pratt notified; diagnosis of attending physician, "bilious malarial fever."

Respectfully,

JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana.

Stroh died about two hours before I received any information of the case. I attended the *post-mortem*, at 9 a. m., August 2. Eight other physicians were present, and among them were Dr. Faget, chairman of State board's committee on infectious diseases, a member, Dr. Von Gohren, and also the president of the State board. The *post-mortem* having been concluded, the opinion was first solicited of Dr. Faget, who declared that the man had died undoubtedly of yellow fever, and, on farther inquiry, it was found that all present concurred in this opinion. My official report was as follows:

"NEW ORLEANS, *August* 2, 1882—10.30 a. m.

"A young German, about two years in this city, died yesterday on the block opposite to the first case of yellow fever. I have just witnessed the *post-mortem*, and concur with the State board that this was an undoubted case of yellow fever. All sanitary precautions taken."

The State board furnished the press with a full and accurate report, which was published, of this case. As the diagnosis was undisputed little need be said regarding it. However, it is instructive that the attending physician visited Stroh from July 30 to his death; that he did not suspect yellow fever until the morning of August 1, and that, notwithstanding this suspicion, he continued to maintain his original diagnosis of "bilious malarial fever," as stated by the president of the State board in the above notification. The latter, having been notified by the former, first visited Stroh about 2 p. m., August 1, and I have good evidence that, on this occasion, the president of the State board counseled the free administration of quinine, both internally and by inunction, and encouraged the attending physician in his diagnosis of "bilious malarial fever." Yet, the man died in four hours thereafter (6.30 p. m.), and, at 10 a. m. on August 2, it was decided unanimously by nine physicians that the death was due, not to bilious malarial, but to yellow fever.

The facts are suggestive, that the president of the State board long hesitated to admit that the first "*typical*" *case* of yellow fever was more than "very suspicious"; that he diagnosed the second case as jaundice, &c., never admitting, as far as generally known, that it was even suspicious; and that he was believed to have encouraged the diagnosis of the third case as "bilious malarial fever"! This third case was finally admitted by the president of the State board as the first case of yellow fever originating in 1882 in New Orleans.

It deserves to be here noted, that it was from July 9 to August 6 that Congress was deciding what action should be taken as to the National Board of Health; that an unfavorable decision was finally rendered on August 6; that any alleged manufacture of yellow fever to influence Congress must have been effected between said dates; and that the only case, during this period, about which any disagreement occurred between the State and National Boards was the case of Dœschler. Therefore, the accusations, for the purpose specified, must be limited exclusively to said case.

The fourth case reported.—I owed my information of this case, Englund's, as also the first, second, and fifth cases to the State officers of the Charity Hospital. Englund was visited by many physicians, all of whom diagnosed his disease yellow fever. Among these were Drs. Faget and Pratt, of the State board committee on infectious diseases. Failing to meet Dr. Faget, the chairman, I succeeded in conferring with Dr. Pratt, who authorized and approved my official report, which was as follows:

"NEW ORLEANS, *August* 10, 1882.

"I concur with State board in a third case of yellow fever in the Charity Hospital since the 9th. It originated in the immediate neighborhood of the first case ('imported')."

The State board furnished the press with a full account of this case. It was officially reported by the president of the State board to be a "mild sporadic case," and on the 11th as "doing well." In spite of this Englund inconsiderately died, on August 15, the sixth day of his sickness.

The fifth case reported (suspicious).—My official report of this case was as follows:

NATIONAL BOARD OF HEALTH,
New Orleans, August 12, 1882.

Prof. JOSEPH JONES, M. D.,
President Board of Health, State of Louisiana:

SIR: By accident I saw in the Charity Hospital at 7½ p. m., 11th, an Irishman, John Buckley, aged sixty years, emaciated, anæmic, and said to be three years in New Orleans, dying with profuse *black vomit*, *albuminuria*, and *free hemorrhage from the penis*. I urged that the State board be notified. Visiting the hospital at 10½ a. m. this day, I witnessed the *post-mortem*, which proved chronic ulceration of the small intestines (there was a history of chronic diarrhœa), but this did not account for the symptoms above mentioned, nor for the *yellow tinge of the skin* being more marked after death. The patient urinated freely and his bladder at the *post-mortem* was distended.

Notwithstanding the presence of some symptoms and the absence of some others not usual in yellow fever, I cannot refrain from serious suspicion that yellow-fever poison played a part in causing the death, and from believing that this case merits all usual sanitary precautions. I have not been informed from what house the man came, but it is said from near the French market. He was brought to the Charity Hospital in a charity wagon.

Respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector.

Soon after this report was written, it was found that this poor old man had been a homeless tramp, who had frequently slept in a police station, within four blocks of the three houses where the three undisputed cases of Forbes, Stroh, and Englund had sickened. All this section of the city was then undergoing disinfection in consequence of the Englund case.

The above letter to the president of the State board was my only official report on this case, copies of said letter having been forwarded, by mail only, to those officers to whom my instructions required me to report. No notice was taken of my communication by the State board; it was never published or otherwise made known to the public, and no official public allusion has ever been made to this case except in the September number of the New Orleans Medical and Surgical Journal. Considering these facts and the date of my report of this case, as well as of the case next to be recorded, it is evident that they had no influence in determining those events which have been denounced as results of the machinations of the National Board of Health.

The sixth case reported (suspicious).—My sole report of this case was forwarded by mail and as follows:

NATIONAL BOARD OF HEALTH,
New Orleans, September 15, 1882.

Dr. CH. SMART, *Secretary:*

DEAR SIR: At 8 p. m. on the 12th I inspected a case of fever which, in the opinion of Dr. Devron, president sanitary council of Mississippi Valley, and of myself, is yellow fever; but since the experienced and reputable attending physician, Dr. Cantrelle, also Dr. Jones, president, and Dr. Pratt, member of the State board, pronounced the disease to be "bilious remittent fever," this case must, under the instructions of the National Board of Health, be regarded officially as a "*suspicious* case," see "Supplement No. 15, Bulletin National Board of Health, Appendix 4 D, seventh." The symptoms indicate, in my opinion, yellow fever, and any doubt about the diagnosis depends chiefly on these two facts: First, the spare, vigorous patient, Fred. Macker, of German parentage, twenty-five years old, was born and has always lived in New Orleans, and therefore was presumably acclimated; and second, while giving to me no history of malarial antecedents for the past five years, he lived in an ill-drained malarial section

of this city. He sickened, September 5, at his residence, No. 212 Port street, eleven blocks, or over a half mile, from the river's bank and directly in the rear of the undisputed yellow fever cases of Forbes, Stroh, and Endlung. Some of the undisinfected ballast of the Ile Marthe from Colon was used to repair the street on a block immediately adjacent to the block on which is 212 Port street.

Unless prompt evidences should be given of a tendency to spread, this case should not cause alarm for the following reasons: It has occurred in a locality adjacent to that very limited part of the city previously known to have been very slightly infected; disinfection of this locality is being enforced; the total deaths last week were only 95, this confirming other evidences of the present favorable sanitary condition of New Orleans; and our weather continues to be exceptionally cool and pleasant.

The following additional facts deserve grave consideration: Dr. Cantrelle notified Dr. Jones that this was a suspicious case on September 11; Dr. Jones paid his first visit on the 11th and held a formal consultation on the morning of the 12th. Dr. Pratt, member of the State board also visited the patient on the 12th, and on this same day Dr. Jones officially invited Dr. Godfrey, the chief surgeon of the United States Marine Hospital Service, to inspect the case as a suspicious one. These facts, together with the disinfection ordered by the State board, indicate that this case must have been regarded as at least suspicious. However, no notice has been received from the State board by myself, the local representative of the National Board of Health, notwithstanding the following facts:

The State board pledged itself to furnish your local representative prompt notice of all real or suspected cases on May 19, 1881 (see Supplement No. 15, Bulletin National Board of Health, Appendix 5, p. 16). The president of the State board gave evidence of its intention to abide by this pledge as late as August 1, 1882, and no notice has been received that the formal resolutions which unanimously indorsed this pledge have been reconsidered or repealed by the State board. My inference from these facts is that in future the State board will not notify the National Board of Health of the presence here of any case or suspected case of yellow fever. My instructions of April 28, 1881, made this one of the two and the chief condition for the establishment of its inspection service here.

My two days' delay in reporting this case has been due to causes satisfactory to myself and approved by Dr. Bemiss, but needless here to detail.

Yours, very respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector.

I inspected this patient but once, and my opinion was founded on the following facts: The high fever had not yielded to quinine; there was intense pain in the back, legs, arms, and head; jaundice supervened; the eyes were intensely red, and injected as well as jaundiced; there was profuse hemorrhage from the gums, tongue, and nose, and there was albuminuria. The general appearance and other indications were to me those of yellow fever. Dr. Devron, who repeatedly visited the patient, the only one of the six who recovered, became more and more firmly convinced that his disease was yellow fever. He also assured me that the intelligent and experienced wife of Macker repeatedly declared that her husband had, about the fourth or fifth day, several times thrown up small amounts of black vomit.

The only notice taken of this case by the State board, as made known to me, appeared in the published proceedings of its meeting on August 14, and was as follows: "Dr. Jones stated, during the meeting, that Dr. Cantrelle had reported to him a suspicious case of fever on Port street, beyond Claiborne. Upon examination he found the man sick with *bilious remittent fever*. This opinion was concurred in by Dr. Pratt and Dr. Cantrelle. Another case, reported by Captain Boylan as requiring investigation, was a man on board the Mexican man-of-war La Libertad. This man was found to have chronic rheumatism, and was sent to the Charity Hospital. The reports of these two alleged cases were well scattered yesterday afternoon, and *the cotton market was affected* 13 *points accordingly*."

In the preceding report the "ballast of the Ile Marthe from Colon" is alluded to. The facts in this matter are as follows: Yellow fever was reported by the newspapers to be prevailing in Colon on May 11, and also on June 29. Vessels from this port were compelled by the Louisiana State board to undergo quarantine in 1882, thus indicating its suspicion, if not its knowledge, that Colon was infected. The Ile Marthe from Colon was quarantined ostensibly for three days, but really from 9 p. m. June 16 to 8 p. m. June 18, and, having moored at a wharf in New Orleans early on the 19th, it remained there until July 13. This vessel had no cargo, but on June 20, 21, and 22 it discharged 300 tons of stone ballast (which the captain stated had been obtained at Colon*) near its mooring, the head of Enghien street. The greater portion of this

* This statement was made and recorded at the quarantine station many days before suspicion was aroused against this ballast, which has since been alleged by the president of the State board to have been shipped in Wales.

large pile of ballast remained where it was discharged until August 16, when it was satisfactorily disposed of by the New Orleans Sanitary Association. Some of it, however, had been used to repair the streets near by. The houses wherein Forbes, the first imported case, Stroh, and England sickened were on the three blocks nearest to this ballast; the police station where Buckley slept was five blocks distant, and the home of Macker was eleven blocks. Thus all of the six reported cases, except Dœschler, had lived near this ballast, and it must not be forgotten that the four last cases had all lived as near to where Forbes, the first "imported" case, sickened. These facts opened the question whether Forbes imported the infection which caused the others to sicken, or whether Forbes, as well as these others, were infected by this ballast. While no one can solve this question, the following facts bearing upon it deserve consideration: Forbes had opportunity for contact with this ballast on the 20th, and he sickened on the 22d. Forbes sailed from Havana on June 11, and therefore, if infected there, the period of incubation was at least eleven days, which much exceeds the ordinary maximum of six days' incubation. If he was infected while on the Marco Aurelio, the steamship which brought him from Havana to New Orleans, then it is singular, though not unprecedented, that a number of other unacclimated persons, who were apparently equally exposed, should all have escaped. There are many instances on record tending to prove that the disused clothing, even of one out of many sailors, may have been infected at a distant port, and may infect the owner when first used by him on his arrival at his destination. Thus, Forbes may have been infected while his comrades escaped.

While our present knowledge does not suffice to solve the questions above suggested, yet not the least doubt is entertained that any board of health which decides that a port is sufficiently suspicious to quarantine the vessels coming therefrom, should decide that the ballast of such vessels is sufficiently suspicious to prohibit its discharge where any person may be exposed to risk of infection therefrom, and its discharge should be much more prohibited in such centers of population as those in which the ballast of the Ile Marthe was discharged.

In closing these remarks on yellow fever in New Orleans in 1882, there are several other general considerations which deserve attention. It is observable that of the three cases admitted by the State board, two occurred in the Charity Hospital and all three died; and that of the six cases reported by the National Board, four occurred in the Charity Hospital and five died. So large a proportion of deaths and of cases in the hospital is unusual though not unprecedented. Were there other cases? To the best of my means and ability I discharged the duty imposed on me of striving to gain information of every real or suspected case. There were only three other cases, all of whom recovered, which came to my knowledge and which might have justified their report as "suspicious" cases. In regard to each of these three cases the circumstances and my own opinion were such that I did not deem myself justified in reporting them. Some might judge me more censurable for this than for what I was censured, viz, for reporting six cases instead of only the three admitted by the State board. I need only say that, in either case, my conscience remains clean and my self-respect untarnished.

In every case which I did report I took good care to present, at the same time with my own evidence and opinion, the evidence and opinion, as far as made known to me, of the State board and of every one else, especially when there was any conflict. No one who fails in this can justly claim that the "whole truth" is being reported. Those to whom I owed duty were treated not like senseless children, but like men with brains enough to weigh evidence and with courage enough to look danger in the face and to provide against it with wise consideration for all interests. No injury to New Orleans has resulted from this course, which, in my opinion, is its best policy. Other communities must distrust it, if good evidence, however unfavorable, is decried, and if good witnesses are unfairly treated. Such has been the case in New Orleans, but justice demands the statement that the records both of yellow fever and of cholera furnish abundant evidence that, under like circumstances, all other communities have been equally censurable. He who has experience and has reflected on this subject must concede that the fault is general and due to human weakness, such as popular appreciation of pecuniary and popular unappreciation of sanitary interests.

INSPECTION OF PASSENGERS REQUIRED BY THE MISSISSIPPI STATE BOARD OF HEALTH.

My first information in regard to this matter was derived from the New Orleans daily newspapers of July 25, 1882, and was as follows:

MISSISSIPPI BOARD OF HEALTH.—RESOLUTIONS ADOPTED AT THE SESSION IN JACKSON YESTERDAY.

JACKSON, MISS., *July* 24.

The State board of health met in session here to-day, with a full attendance. The following resolutions were adopted:

Resolved, That in case the inspectors of the National Board of Health at New Orleans should be discontinued, then the Mississippi board of health shall address a letter

to the Louisiana board of health asking their permission to send an agent or inspector to the city of New Orleans, whose duty it shall be to examine into the characteristics of any suspicious cases of fever occurring in that city in order that this State board may have accurate, reliable, and prompt information in case of the outbreak of yellow fever.

That should the National Board discontinue its inspection stations in the south before the period of danger from yellow fever expires, this board will establish stations of inspection at Osyka, Fort Adams, and a point just below Vicksburg.

That whenever two or more cases of yellow fever shall have originated in New Orleans, Mobile, or any other place contiguous to our borders, a thorough system of quarantine will be established at once against such place by this board.

That should there arise any circumstances of danger of epidemic invasion not covered by the foregoing resolutions, the executive committee is hereby authorized to adopt such measures of inspection and quarantine protection as they may deem prudent and proper.

The resolution which I have italicized in the above deserves special note, since it throws light on the subsequent action of the Mississippi State board, which action was severely denounced by the Louisiana State board and the press of New Orleans.

My next information bearing on this subject has already been recorded, as follows: On June 26 Forbes died of yellow fever and was reported by the State and National Boards to have been the first case ("imported"). On July 17 Dœschler died of yellow fever, as certified by the officers of the Charity Hospital, and as recorded by the State board, and of *suspected* yellow fever, as reported by the National Board of Health; this constituting either the first case or the first suspected case *originating* in New Orleans. On August 1 Stroh died of unquestioned yellow fever, and was so reported by both the State and the National Boards, so that no one disputed that this case originated in New Orleans. On August 10, both the State and National Boards reported that Englund had yellow fever, and no one disputed that this was at least the second, if not the third, case originating in New Orleans.

Recalling the resolutions of July 24, of the Mississippi board, no one ought to have been surprised at the action of said board as recorded in the New Orleans newspapers of August 12 and 13, as follows: "JACKSON, *August* 11.—Dr. Johnston, secretary of the State board of health, has to-day received information of a case of yellow fever in New Orleans. In accordance with the requirement of the State board of health steps will be immediately taken to establish quarantine stations where needed." And, "JACKSON, MISSISSIPPI, *August* 12.—The Mississippi State board of health will immediately establish quarantine stations at Osyka, on the New Orleans and Chicago Railroad, at Fort Adams, on the Mississippi River, and at a point in Hancock County on the Mobile and New Orleans Railroad, the latter under the charge of Dr. Rice, of Vicksburg. *The certificate of the National Board of Health will be required from all persons traveling.*" Further on August 14, a proclamation, for the purpose of enforcing all of these resolutions and the so-called "modified rules and regulations" of the Mississippi board, was approved by "Robert Lowry, governor."

It was on this day, August 14, that I first had anything whatever to do with the Mississippi board, and I have reason to believe that, to this date, neither the National Board of Health, nor any of its members, had either greater knowledge or had interfered more in this matter than myself. There had been thus far no interference or suggestion whatever. The New Orleans papers of the 13th had called attention to Dr. Bemiss's telegram of August 12, deprecating the alarm of Galveston and its threatened quarantine of New Orleans. But, on the 14th, a member of the executive committee of the Mississippi board arrived in New Orleans, urged Dr. Bemiss and myself, and telegraphed the National Board of Health, to co-operate with the Mississippi board in what had been determined on. Dr. Bemiss and myself did all in our power to dissuade the Mississippi board from requiring the co-operation of the National Board of Health in establishing an inspection of passengers. Solicited on the 14th, the National Board of Health gave no decisive reply until August 23, when it telegraphed that "the Board does not feel authorized to establish the passenger inspections at New Orleans at present." Soon thereafter, when yellow fever was devastating Matamoros and Brownsville, and had appeared at Pensacola,* a second representative of the Mississippi State board was sent to New Orleans to re-enforce the demands of his board on Dr. Bemiss and myself. We replied that we were not empowered to establish an inspection of passengers, and that we would not advise it, unless yellow fever should show a great tendency to spread. In the mean time the Mississippi board persisted in its demands on the National Board of Health at Washinton. Required by law to aid and co-operate with State boards, the National Board of Health finally sent me, on September 1, the order recorded in the subjoined letter. In view of the subsequent accusations made, it deserves statement that this letter contained the first

* Pensacola was promptly quarantined by New Orleans, as also by Alabama, Mobile, and other places.

words ever wrttien by me to the Mississippi State board, or to any member thereof. It also deserves notice that the policy urged in this letter was the policy advocated by myself, by Dr. Bemiss and by the National Board of Health from first to last.

NATIONAL BOARD OF HEALTH,
New Orleans, September 1, 1882.

Dr. WIRT JOHNSTON,
Secretary Mississippi State Board of Health:

DEAR SIR: I received at 11 a. m. this day a telegram, of which the following is a copy:

"WASHINGTON, D. C., *September* 1, 1882.

"To D. S. E. CHAILLÉ,
"*National Board of Health, New Orleans, La.:*

"Wirt Johnston's request for passenger inspections at New Orleans is granted. Communicate with him, appoint men, and make necessary arrangements for service. Forward particulars for action of committee.

"SMART, *Secretary.*"

In compliance with the above, I respectfully report that I will be prepared, on or after September 3, to enforce the rules and regulations of the National Board, of which I inclose a copy, in reference to the inspection of passengers, and that I will also enforce, to the extent of my power, any additional rules and regulations which may be forwarded to me by the Mississippi State board of health. The aforesaid rules and regulations will be applied to all river craft and railroad lines which pass from this city beyond the State line of Mississippi.

Your attention is respectfully solicited to the following additional facts: I have good reason to believe that no case or suspicious case has occurred here since Englund, who sickened on August 9 and died on the 15th; I therefore believe it now useless to inaugurate a passenger inspection service. Inspectors would be forced to impose an annoying formality on passengers without securing additional safety to other communities. The comprehension of this fact by the public would tend to increase its hostility to the restraints of sanitary authorities whose power and influence are already too feeble.

I therefore recommend that you intrust the inauguration of the passenger inspection service to Dr. Bemiss and myself, leaving it to us, who are here on the ground, to decide the time when such service shall be established. In such case prompt action would be taken on the earliest evidences of real danger, and you would be duly notified thereof.

Although I have a strong conviction that these views are wise and the most expedient, I am none the less fully prepared to execute any different conclusion which I may be instructed by you to execute.

Yours, very respectfully,

HANFORD E. CHAILLÉ,
Supervising Inspector National Board of Health.

Dr. Johnston's answer was not received until September 4. It persisted in the demand first made to me on August 14, and continuously repeated. Believing that, under the circumstances, the public was entitled to at least one day's notice, I advertised due notice on the 5th, delayed inaugurating the inspection of passengers insisted on by the Mississippi State board until the 6th, and closed it on September 30, with the full approval of said board.

In view of all the facts now presented, it is difficult to understand how the Mississippi State board could have acted differently, provided that its resolutions of July 24 were wise; and, if unwise, it is singular that there was no protest against them, not even by the Louisiana State board, and the New Orleans papers, which so violently denounced the inevitable results of these resolutions. It is still more difficult to understand how the National Board of Health could have acted differently and why it should have been abused by the very city which it protected from the severer quarantine restrictions, which would certainly have been imposed by the Mississippi board in case the National Board had refused the former its co-operation. The National Board was organized to substitute legalized and modified quarantines for "shotgun" quarantines. I am even less able to comprehend what I, an officer bound to obey orders, could have done, consistently with my duty and truth, more than was done in behalf of New Orleans.

It has been shown that the Mississippi State board resolved, July 24, on what contingency it would act; that it decided, August 10 and 12, that said contingency had been realized, and that the National Board had not, to said date, reported any cases of yellow fever, except those four recorded in the published weekly reports of the Louisiana State board of health. Additional evidence that the National Board did

not influence this decision, as was charged, is found in the following facts: Proclamations, resolutions, and correspondence with Texas and Galveston, with Tennessee and Memphis, with Alabama and Mobile, all prove conclusively that all of these were, like Mississippi, awaiting only a word of unfavorable advice to quarantine New Orleans. Now, identically the same information and advice were given alike to all, and yet the action of Mississippi alone was unfavorable to New Orleans; for the reason, no doubt, that none of the others had defined as vigorously the contingency on which they would act, as had been done by Mississippi on July 24. Further, none others are as much exposed to infection from New Orleans as is Mississippi, and therefore none others are so much tempted to make early and efficient preparation against danger.

In truth, the Mississippi State board took precautions against a danger which was threatened rather than against a danger believed to be present. It remained perfectly content with restrictions on passengers so slight that it was an abuse of ordinary language to term these restrictions a quarantine. In fact, although the New Orleans press ridiculed and denounced this so-called "Mississippi quarantine," yet not a single complaint was addressed to me by those most directly interested, passengers, steamboats, and railroads. The railroad agents took the trouble even to thank me, and replied to my question, whether the inspection of passengers had in any wise diminished their business, that while it may have done so to some slight extent, yet that the injury, if any, was inappreciable; for they had had an exceptionally large business during the very time when these inspections were enforced.

All the facts having now been recorded concerning the action in this matter of the Mississippi and of the National Boards of Health, the views of the Louisiana State board, as published in the local papers of September 8, will be presented. They were adopted on the 7th, as follows:

"1. It is evident from the documents submitted by the president to the consideration of your conference committee, that the request of the health authorities of Mississippi, that the National Board of Health should sustain them in their assertion that New Orleans was an infected city, and in the establishment of a *de facto* quarantine against our city, and aid them in an effort to restrict the rights and liberties of the citizens of New Orleans and of the entire State of Louisiana, by the enforcement of the rules and regulations of the National Board of Health governing localities and people, has been granted by the said National Board of Health.

"2. The National Board of Health and the health authorities, as well as the civil authorities of Mississippi, proclaim New Orleans an infected city, and said proclamation has been published daily since the 5th of September, signed by Prof. S. E. Chaillé, M. D., supervising inspector National Board of Health. Every certificate demanded and signed by the National Board of Health to the citizens of Louisiana, repeats the assertion that New Orleans is an infected city, and that its citizens are liable to carry infection wherever they go, and are therefore fit subjects for the fears, ill-usages, suspicion, and abhorrence of surrounding communities.

"3. It is well known to all honest, unprejudiced, and truthful citizens that New Orleans is absolutely free from the infection of yellow fever, no case having occurred during the past twenty-eight days. The official record of the State of Louisiana shows that New Orleans is in the enjoyment of remarkable health, and that her death rate will compare favorably with that of any city of similar size in Europe or America. Now, facts have been fully communicated by the president of the board of health to the sanitary authorities of Mississippi, as will be seen from the following telegram addressed to the secretary and executive officer of the board of health of the state of Mississippi:

"BOARD OF HEALTH, STATE OF LOUISIANA,
"'*New Orleans, September* 5, 1882.

"'To WIRT JOHNSTON, M. D.,
"'*Secretary Mississippi State Board of Health:*

"'Please state to the board of health upon what facts the Mississippi state board of health requires from every person leaving New Orleans for any place within the State of Mississippi a health certificate of the National Board of Health. No case of yellow fever has occurred in New Orleans for the past twenty-six days. New Orleans is in good sanitary condition and in a state of remarkable health. You do great injustice to the merchants and citizens of New Orleans and the State of Louisianna. Justice demands the statement herein requested.

"' JOSEPH JONES, M. D.,
"'*President Board of Health State of Louisiana.*'

"4. The action of the National Board of Health and civil authorities of Mississippi violates both the letter and spirit of article 10, section 1, of the Constitution of the United States, which ordains that 'full faith and credit shall be given in each State

to the public acts, records, and judicial proceedings of every other State.' The members of the board of health of the State of Louisiana have been appointed, in compliance with the constitution and laws of the State, by his excellency Gov. S. D. McEnery and by the honorable the city administrators of New Orleans, and have been confirmed by the general assembly and duly commissioned by the governor of Louisiana. Each and every member has taken the oath of allegiance to the State of Louisiana and the United States of America, and has so sworn to obey all laws designed for the preservation of the health of the people and the exclusion of foreign pestilence. No reply has been received to the direct and emphatic demand by our president for the facts upon which the health authorities have proceeded, in conjunction with S. M. Bemiss, resident member of the National Board of Health, J. L. Cabell, president of the National Board of Health, Army Surgeon Smart, secretary, S. E. Chaillé, M. D., supervising inspector, and other members and employés of the National Board of Health, to brand and defame this healthy city as an infected port or place. The meetings and proceedings of the board of health are open to the press and to all respectable citizens of this and other States and countries. There is no official record of the deaths and causes of deaths but that preserved by law by the board of health of the State of Louisiana and open to the inspection of all State and national officers, medical, naval, military, and civil, and to the representatives of the press and all reputable citizens. The National Board of Health has no other reliable or truthful data in its possession except that recorded according to the law upon the books of the State board of health.

"5. The conference committee have in their possession facts to show to those authorized by law to conduct the investigation that the National Board of Health has been engaged in a systematic effort to undermine and destroy the influence of the State board of health. Every action of the resident member of the National Board of Health and of the supervising inspector has been at recent date fully recorded in the August and September numbers of the New Orleans Medical and Surgical Journal.

"6. In view of the preceding facts your committee would respectfully urge the passage of the following resolutions:

"*Resolved by the board of health*, That his excellency the President of the United States, the Senate and House of Representatives, be respectfully requested to order a special and thorough investigation of the conduct of the National Board of Health, and especially of its relations to the board of health of the State of Louisiana, and of the mode in which the National Board of Health expended the public funds in *this* State.

"*Resolved*, That the secretary of the board of health be instructed to print the foregoing report and resolutions, and to forward the same to his excellency the President of the United States, to the honorable Senators and Representative of the United States, and to the governors of the several States and executive officers of the State board of health."

Respecting these views, I avoid all comment, since too great a temptation is presented to transcend official decorum. However, four sets of official acts will be recorded by way of comment and explanation. It will be observed that the Louisiana State board declared that "a proclamation has been published daily since the 5th September, signed by Prof. S. E. Chaillé, M. D., supervising inspector National Board of Health," which "proclaims New Orleans an infected city." The only so-called proclamation signed by me was the following advertisement: "In compliance with the *requirements of the Mississippi State board of health*, every person leaving New Orleans, destined for any place in Mississippi, will be required, after September 5, to hold a passenger's certificate of the National Board. No certificates will be required at present from passengers traveling through the State without stopping therein. The necessary certificates can be procured by personal application to," &c. Very certainly New Orleans was not proclaimed to be infected by the National Board of Health.

The telegram above recorded, of the president of the Louisiana State board, to the secretary of the Mississippi State board, promptly received the following reply:

"Your telegram received. I respectfully reply that the present inspection was established by the executive committee of the Mississippi State board of health under a resolution of inspection passed by the board after careful consideration. The State board is not now in session, nor is a quorum of its executive committee present. I will add, with all respect for your request, that I am not authorized to give explanation to other boards, in the name of the Mississippi board of health, of the reasons for its official action.

"WIRT JOHNSTON,
"*Secretary Mississippi State Board of Health.*"

This reply having been read at the meeting, on August 7, of the Louisiana State board, by its president, he, Dr. Jones, continued: "This looks like concealing matters, while we are in the habit of giving everything to the world. I regard putting restric-

tions of this kind as an outrage upon the people of New Orleans and of Louisiana. That it is done under a pretense of protection makes it still more wanting in anything like justice. If we had yellow fever here New Orleans would be the first to let the world know it. We have no concealment whatever to make in matters of this kind."

At the next meeting of the Louisiana State board, on September 14, its president re-enforced this view as follows: "The establishment of quarantine restrictions against one of the healthiest cities in America or Europe, and at a time of unexampled health even in this city, is a *crime*, and its authors [the governor and State board of Mississippi] should be dealt with by the strong arm of the law."

Notwithstanding all this, the same president of the Louisiana State board strenuously urged his board, at the next meeting, on September 21, to quarantine Corpus Christi, Texas, a healthy place, which had not reported even three cases of yellow fever. A number of arguments were used, and among them the following: "When yellow fever is prevailing to such an extent in the triangle of which Corpus Christi, Laredo, and Matamoros are the salient points, the board of health of the state of Louisiana are solemnly bound to protect New Orleans and the entire Mississippi valley by proper quarantine regulations against Corpus Christi. Yellow fever may be reported as absent from Corpus Christi by telegraph yesterday and at this moment be present." The Louisiana State board declined to adopt the president's proposition, but it is difficult to understand why his arguments to justify the Louisiana board in quarantining Corpus Christi, where no cases of yellow fever had occurred, should have been deemed totally insufficient to justify the Mississippi board in quarantining New Orleans, where some cases had occurred.

The governor of Mississippi, having also been appealed to, gave a reply which seemed to be as unsatisfactory to New Orleans as was the reply of the secretary of the Mississippi State board of health.

Finally, the present subject will be concluded with the two following records, published in New Orleans on September 13 and 16, and made by the Mississippi State board of health on September 12.

First:

"Whereas yellow fever prevails epidemically at Havana, Brownsville, Matamoros, and Pensacola, and is liable to extend to this State by way of New Orleans, especially owing to the lax and inefficient system of inspection and quarantine obtaining at that port, as signally evidenced in the well-known Forbes case:

"*Resolved*, That our present inspection stations be continued under the modified quarantine regulations, framed by our executive committee, until the 1st of October, unless yellow fever should threaten to become epidemic in New Orleans, in which event the regular quarantine rules of this board shall be strictly enforced. The board hopes and believes that all good citizens of the State will appreciate the grave responsibility that rests upon it, and second its efforts to keep yellow fever from our border."

And, second:

"Whereas certain attacks have been made against the official integrity of the National Board of Health and the State board of health of Mississippi in connection with the system of inspection now enforced against the city of New Orleans by the State of Mississippi; and

"Whereas, while the State board of health of Mississippi, in the pursuit of their official obligations, regard with a feeling of indifference the unjust assaults made upon them, yet they feel called upon by every feeling of honor to repel the charges made against the National Board by their enemies that they have entered into any league or conspiracy with the National Board for the aggrandizement of the National Board, or for any other purpose; Therefore, be it

"*Resolved*, That this board declare and proclaim their full and entire responsibility for any and all steps taken heretofore in establishing the system of inspection now in force against New Orleans."

In concluding the general subject of "The National and the Louisiana State Boards of Health in 1882," attention is called again to the resolutions of the State board, which were so defamatory to the National Board, and were adopted on July 13 and September 7, the former being founded solely on a false newspaper telegram and the latter on a gross misapprehension of the influence exerted by the National Board on the Mississippi State board. To this record, already made, it deserves to be added that from early in July to August 7 the National Board was struggling for existence in Congress, and that in the published proceedings of every meeting of the State board, from July 13 to September 14 inclusive, there appeared some denunciation or misrepresentation or action calculated to injure the National Board in public estimation. In the mean time the attacks of the newspaper, which has long been the prejudiced partisan of the State board, were incessant, yet not one of these attacks was founded wholly on the truth.

II.—INTRODUCTION OF YELLOW FEVER IN NEW ORLEANS IN 1882 AND ITS FAILURE TO SPREAD.

While neither the one nor the other of these occurrences can be explained so decisively as to give satisfaction to all, there are some facts bearing on the questions involved and deserving record.

On April 13 the State board of health requested from the governor a quarantine proclamation, which was issued on the 17th and complied with the conditions recommended by the board. These were, that on and after May 1 a quarantine of "*three full days*" should be imposed on all vessels from the eight infected ports of Rio, of Vera Cruz, of the three Cuban ports of Havana, Matanzas, and Santiago de Cuba, of Port au Prince (Jamaica), of St. Pierre (Martinique), and of Pointe-à-Pitre (Guadaloupe). Such other ports and places as might thereafter be declared infected by the board of health were to be subject to such quarantine as might be directed by the State board. This proclamation was amended on June 12 in compliance with the recommendations on June 8 of the State board. It extended the period of quarantine detention to "*ten full days*" on and after June 15, "provided that the port of Vera Cruz, which is *known to be at present perfectly healthy*, shall be exempt from the effect of this proclamation until the further date of July 1, 1882."

Although no evil results are known or even suspected to have ensued in 1882 from this proviso, yet it was believed to be dangerous. The records of yellow fever prove, and my own experience, especially in Cuba, convinced me that very great difficulty is encountered, even by a disinterested medical inspector, and even when on duty at the very port habitually infected, in determining, at times when yellow fever is not prevalent, that no cases exist. Ordinary evidence in such a case does not enable one to "know" that such a place is free from the danger of importing infection. In truth, there is much evidence tending to prove that, in habitually infected places, such as is Vera Cruz, the poison is ever present; and that though it may remain temporarily dormant and inappreciable, yet this dormant poison may be exported, and should it elsewhere find the conditions requisite for its revivification and growth it may give rise to pestilence even at a distant place.

The dates prescribed by quarantine proclamations are always interpreted, as I am informed, to apply to the port of departure. For instance, if it be proclaimed that vessels from a specified port will be quarantined ten full days "on and after June 15," such detention is enforced, not against the vessels which arrive after said date at the quarantine station, but on those only which departed after said date from the infected place quarantined. In any case, the Marco Aurelio, on which Forbes, the first ("imported") case, came to New Orleans, left Havana June 11 and was quarantined June 14–17, only three full days. He sickened on June 22, at which date he would have been at the quarantine station had the ten days' detention been in force.

Few will doubt that infection was imported either by the Marco Aurelio and Forbes on June 18 or by the suspected ballast from Colon, which ballast was discharged in New Orleans June 20 to 22. Either hypothesis would account naturally for five out of the six cases reported, viz, for all three of the undisputed cases and for two of the three "suspicious cases." Either cause would also account for one of the three cases which have been alluded to as having aroused the temporary suspicion of some, but were not reported. This case occurred about the middle of July on the same block where Stroh lived and immediately adjacent to the block where Forbes sickened.

Proof is impossible, but it is my firm belief that the "suspicious case" of Dœschler was one of veritable yellow fever. No source of infection could be traced in this case, which occurred some 3 miles distant from the other five reported cases. Two of the unreported cases also occurred above, and at a distance from said five cases. In each of these two cases the two different attending physicians, both of whom were reputable and experienced physicians, expressed the belief that the disease was yellow fever. I did not concur in respect to the only one of these cases seen by me. Both occurred in September. If the attending physicians correctly diagnosed these two cases, then the source of their infection is as obscure as in the Dœschler case. But the inability to trace infection does not, by any means, disprove its existence, and the frequency with which undoubted cases of yellow fever have not been traced to any communicable source is so notorious that there still remains a considerable number of physicians who believe in the local origin of the disease. In proportion to their efficiency quarantines diminish the risks of infection, but there never has been a quarantine yet, and it seems improbable that there ever will be one, which has or can cut off all risks. In 1880, and again in 1882, quarantined vessels imported yellow fever infection into New Orleans, as is known, and it is impossible to deny that infection may be imported and remain unknown. The victims are often the only persons who could furnish the clews for tracing the source of the disease communicated, but it frequently happens, as happened this year in five of the six reported cases, Dœschler included, that the victims' minds are so affected by the disease or that the circumstances are

such that reliable and full information cannot be procured from them. The inexperienced inadequately appreciate the detective patience and skill required in such investigations.

It deserves note that apart from risks at quarantine stations, New Orleans is exposed at other avenues of approach. During the present season an instance was brought to my notice in which one of our residents arrived in New Orleans in five days from Havana, via Tampa, Fla., and the railroad. I have reason to believe that a season never passes without some such arrivals from infected places. These persons are accompanied, of course, by at least their personal baggage, trunks, &c., which are usually deemed by sanitarians especially dangerous.

Yellow fever having been introduced in 1882, why did it not so spread as to cause greater injury? And here it should be remembered that, whatever dispute there may be as to the actual number of cases of yellow fever, the reports of the total deaths and of the total cases of sickness by all diseases continued throughout the season to be so favorable that it is certain there could not have been any large number of yellow fever cases. The first case occurred at an alarmingly early date, in ample time for a disastrous epidemic. Though doubting whether the following causes furnish adequate explanation of the failure of the disease to spread, they, none the less, deserve record.

The sanitary condition of New Orleans was better than usual. Disinfection was practiced more thoroughly, as is believed, than customary. The summer was exceptionally cool and pleasant. During the most dangerous period rains were so frequent that streets and gutters were either well cleansed or even flooded almost daily. An additional cause was doubtless the large number of the population protected by acclimation, especially, as is reported, in the limited section of the city, where the larger number if not all of the cases occurred. Some of these causes were probably as potent in Brownsville and Pensacola where the disease did spread, as in New Orleans, where it did not.

III.—THE INSPECTION SERVICE IN 1882.

The inspection service at New Orleans and under my control was closed in 1882, as in 1881, on September 30. The following list includes the names of all the officers (10) and of all the employés (2) in this service, together with the date of the commencement of the service and the nature of the service of each:

ROSTER.

Names.	Date of commencement of service.	Duty discharged.
Dr. S. E. Chaillé	April 1	Supervising inspector.
Dr. William Martin, U. S. N	April 24	In office of supervising inspector.
Dr. P. B. McCutchon	May 14	River service, inspector of freight.
Dr. F. W. Parham	...do	Do.
Dr. G. F. Patton	May 15	Inspector at Mississippi River quarantine station.
Mr. William Warder	.. do	Engineer of steam-launch at quarantine station.
Mr. R. Cobden	...do	Fireman of steam-launch at quarantine station.
Dr. L. F. Salomon	June 30	Railroad service, inspector of freight.
Dr. J. M. Watkins	...do	Do.
Dr. S. C. Russell	Sept. 5	Railroad service, inspector of passengers.
Dr. Henry Bezou	...do	Do.
Dr. S. R. Olliphant	...do	River service, inspector of passengers.

All of these were on duty in New Orleans, except one inspector and the two employés indispensable for the steam-launch lookout, who were located a the Mississippi River quarantine station, some 70 miles below New Orleans. All of my subordinates discharged their duties intelligently, zealously, and satisfactorily.

Most of the expense of the service has already been paid, so that the balance can be accurately estimated within $50. The maximum total expenses for all purposes are appended:

Sum total of all expenses	$7,750
Expenses paid by two railroads	910
Balance paid and incurred by the National Board of Health	6,840

It is believed that the expense to the National Board of Health will not exceed $6,800. Among other accusations against the National Board of Health, it was charged that the expense of its inspection service in New Orleans was really borne by the railroads and steamboats. The above statement discloses all of the truth in this accusa-

tion. Since the organization of the National Board of Health in 1879, each railroad has cheerfully consented annually to pay one inspector of the National Board of Health to satisfy the communities traversed, and therefore, for self-protection. Neither in 1881 nor 1882 was an inspector assigned to duty on the Louisiana and Texas Railroad for the two reasons that the communities traversed did not demand it, and that I did not deem them in danger of infection from New Orleans. As the boards of health of Tennessee (after the occurrence, on June 26, of the first yellow-fever death) and of Mississippi did demand inspectors on the two railroads of New Orleans which traverse these States, they were therefore assigned to duty. This is the whole truth in this much misrepresented matter.

It is believed that $7,750 is a burden disproportionately small compared with the benefits conferred on the commerce of New Orleans and the Mississippi Valley. The confidence inspired in other communities by the inspection service has tended beyond question to protect commerce. It is not doubted that the future will so prove this as to bring conviction to all.

MISSISSIPPI RIVER QUARANTINE SERVICE.

The details of this service will be found in the accompanying report of Inspector Patton. Its publication is recommended, and especially of the concluding valuable tables for 1881 (completed) and for 1882 (incomplete). These tables are a continuation of those presented in Dr. Patton's report for 1881.

The following statistics for the full year 1881—a year very favorable for the commerce of New Orleans, and furnishing a fair basis for the estimate of the same data for 1882—are of interest. They refer exclusively to the Mississippi River and its quarantine station.

Total number of vessels of all kinds arrived	1,048
Total tonnage (estimated)	773,600
Total number of persons, crews	25,590
Total number of persons, passengers	6,744
Total number of vessels quarantined	122
Total number of vessels infected on arrival at quarantine station	6
Total number of vessels developing disease at New Orleans	0

Of the six vessels reported infected on arrival at the quarantine station, there were only two believed to be infected with yellow fever. These were so reported by the inspector of the National Board of Health at Havana.

RIVER SERVICE—INSPECTION OF FREIGHT.

The accompanying report of Inspectors McCutchon and Parham is respectfully referred to. In addition to other valuable service rendered by them, they inspected, during the period of their service, May 15 to September 30, 262 river craft, viz: 146 steamboats, 112 barges, and 4 other kinds of river craft.

RAILROAD SERVICE—INSPECTION OF FREIGHT.

Inspector Salomon was assigned, as in 1881, to the New Orleans, Saint Louis and Chicago Railroad, via Jackson, Miss., and having a branch to Memphis, Tenn.; and Inspector Watkins was assigned, as in 1881, to the Louisville and Nashville Railroad, via Mobile. Attention is called to the report of each of these inspectors. They were on duty June 30 to September 30; during this time their inspections embraced the following items:

Numbers inspected.	New Orleans, Saint Louis and Chicago Railroad.	Louisville and Nashville Railroad.
Number of freight trains	207	196
Number of persons thereon	1,035	1,163
Number of loaded freight cars	2,552	2,485
Number of empty freight cars	2,537	2,544

There having been no outbreak of yellow fever, very slight restrictions were imposed on traffic, and these restrictions were limited to rags, paper stock, second hand bedding, hides, wool, and glue stock. Special attention was given to freight to Memphis and such places as requested it.

Inspector Salomon reports that, "At the request of the management of the road, I began on July 16 to issue separate special certificates for each car destined to Memphis, Tenn. One hundred and forty-five of said certificates were issued to that number of loaded cars. The wisdom of this action, as well as the utility of the inspection service, was demonstrated by the fact that not one pound of freight shipped for Memphis was delayed or refused transportation, and that, without these certificates, no freight from New Orleans would have been allowed to enter that city," as was proclaimed on July 12 in "Health Order No. 14" of the Memphis board of health.

The railroad managements located in New Orleans have always shown the highest appreciation of and the most cordial co-operation with the National Board.

INSPECTION OF PASSENGERS TO MISSISSIPPI.

This service included the twenty-six days, September 6–30. It was conducted by Inspector Russell for the New Orleans, Saint Louis and Chicago Railroad, by Inspector Bezou for the Louisville and Nashville Railroad, and by Inspector Olliphant for river craft. The report of each of these is inclosed.

Passengers for the two nearest sea-coast counties of Mississippi were not inspected. Hancock and Harrison Counties are virtually suburbs of New Orleans in the summer; hence their boards of health objected to the inspection of passengers, and the Mississippi State board acceded thereto. By consent of the Mississippi State board, passengers on excursion trains to border towns were permitted to travel without health certificates, but not without inspection. The number of passengers to whom certificates were supplied were as follows:

On the New Orleans, Saint Louis and Chicago Railroad	1,539
On the Louisville and Nashville Railroad	144
On river craft	156
Total passengers	1,839

CONCLUSION.

In the final reports for 1881, of myself and subordinate officers, attention was called to numerous facts and to some recommendations bearing on the good of the service. It is needless to repeat these, but you are respectfully referred thereto.

To Dr. S. M. Bemiss, local member of the National Board of Health, I owe cordial thanks for aid, approval, and encouragement in the discharge of duties which were at times perplexing and still oftener harassing. I have reason to believe that I have maintained the confidence and gained the approval of all other communities than my own. My partial failure in the latter I attribute to unfortunate circumstances, and not to any fault of mine as yet recognizable by me.

My position and influence with my profession, my reputation in New Orleans, and my identification with it, have provided me exceptionally favorable opportunity, on the one hand, to procure prompt information of infectious disease, and, on the other hand, to reconcile the sanitary interests and public sentiment of this community with those of the Mississippi Valley and of the country generally. I have become convinced that, at present, the last is impossible, at least to that degree which would prove satisfactory to all conscientious sanitarians wherever located. My office imperatively requires that infection should be diligently sought for, and that other communities should be promptly warned of its presence, in order that they may provide against it in ample time. Nothing less than the whole truth, and *all of the evidence bearing on it*, will satisfy these, and to furnish this dissatisfies New Orleans. If it be urged that failure to warn others will cause them to inflict grave injury on commerce, such a plea is indignantly resented as a *threat*.

The representative, in any place, of the sanitary interests of other places, must run the risk of reporting danger too soon rather than too late; while the natural tendency of this and of every community is to prefer that the health of others as well as of themselves should be jeopardized rather than that their own pecuniary interests should be made to suffer. This natural conflict will not cease until self-interest becomes more enlightened; and it is feared that the lash of pestilence will be again and again required to convince some succeeding generation that public health is of supreme importance, that its protection best promotes commerce, and that this protection depends on the promptest recognition of danger and the promptest adoption of defensive measures against infection.

Whoever strives in one community to do this much in behalf of another must now incur the prejudice of the former; and this prejudice, against a physician in his own home, is so detrimental and unpleasant that I hope never again to occupy, under like circumstances, such an office as has been mine during the past two years.

Yours, very respectfully,

STANFORD E. CHAILLÉ,
Supervising Inspector.

SEVEN FINAL REPORTS FOR 1882 *OF EIGHT INSPECTORS OF THE NATIONAL BOARD OF HEALTH, AT NEW ORLEANS, LA.*

FINAL REPORT OF DR. G. FARRAR PATTON, INSPECTOR AT MISSISSIPPI RIVER QUARANTINE STATION, SEASON OF 1882.

MISSISSIPPI RIVER QUARANTINE STATION, *September* 30, 1882.

DR. STANFORD E. CHAILLÉ,
Supervising Inspector, National Board of Health:

SIR: My term of service as inspector of the National Board of Health at the Mississippi River quarantine station for the season of 1882 closing with this the last day of September, I have the honor to submit the following report upon the events and quarantine operations of the season up to date:

The detention of vessels from infected and suspected ports was begun under the usual proclamation of the governor of Louisiana on May 1, the period of detention being three days. The inspector of the National Board of Health was assigned to duty on May 15, but, owing to delay caused by necessary repairs upon the steam launch forwarded from Memphis for his use, did not reach the Mississippi River quarantine station until May 16, previous to which date nine vessels, including one with a partial cargo of coffee from Rio de Janeiro, had been quarantined and released.

On June 15 the period of detention for quarantined vessels was, by a second proclamation, increased to ten days, vessels from Vera Cruz being excepted. These latter, on account of Vera Cruz continuing remarkably healthy, were detained only three days up to July 1, after which the ten days' detention was enforced against all vessels from ports embraced in the quarantine proclamations. However, as will be seen by my weekly reports and as set forth in the accompanying table "giving a *résumé* of quarantine work" up to date, certain vessels from ports not actually infected with yellow fever have been detained from one to four days for purposes of disinfection and observation, this measure being enforced by the State officers as an extra precaution.

It is gratifying to note that up to this date not one case of yellow fever, nor even a suspicious case of any kind, has appeared at the Mississippi River station. Several schooners from small ports on the coast of Mexico have had cases of malarial fever on board, before arriving at the station and afterward, and from three of these vessels one man each has been buried in the quarantine cemetery, but all these cases have been of undoubted malarial character, as established by their clinical history and symptoms and by *post mortem* examination of the bodies. In this connection it is not inappropriate to remark that, while severe malarial fevers have prevailed along the Mexican and Central American coast during this season, yellow fever has been almost entirely absent. Two cases are reported to have occurred in Vera Cruz in May, but since then that city has been exceptionally healthy.

In the city of Rio de Janeiro the deaths from yellow fever have been remarkably few during the past five or six months, and, as reported, the disease has not invaded the shipping. On this account the few vessels which have arrived in the Mississippi River with small cargoes of coffee from Rio de Janeiro during this summer have not been required to discharge the same into the quarantine warehouse, as was done during the season of 1881.

In Havana, as usual, yellow fever has been epidemic during the summer, and in June and July the deaths from this cause were particularly numerous, considering the large proportion of the inhabitants of the city who must needs be acclimated. In the smaller Cuban ports the disease has prevailed to a very slight extent, some of the more important towns having escaped entirely.

Fortunately for New Orleans very few vessels have arrived direct from Havana during the summer, and these have brought, as a rule, neither cargo nor passengers. The large Spanish steamers arriving from Cuban ports generally stop only three or four days in Havana, from which place they touch at two or three of the smaller ports before sailing for New Orleans, so that on arrival here they have usually been more than a fortnight out from Havana.

The case of the steamer Marco Aurelio, one of the crew of which vessel died of yellow fever in New Orleans after having been three days at sea, three in quarantine, and four in the city, making ten full days after leaving Havana, does not strictly come within the scope of this report, but deserves a passing notice. This vessel, an iron steamer only nine months old, was in an excellent sanitary condition, and had no cargo, thus affording a fair opportunity for the powerful fumigation employed to reach every part of the hold, so that the occurrence of a case of yellow fever among her crew, as above stated, seems to leave no doubt but that the poison of the disease was

latent in the man's system from the time he left the infected port of Havana.* The significance of this episode as bearing upon the question as to how long a vessel should be quarantined after leaving *a positively infected port*, like Havana, is sufficiently obvious. No other case of fever occurred among the thirteen men returned to the quarantine station on the Marco Aurelio, nor, as far as known, among the remainder of the original twenty composing the crew.

During the season only one cargo, consisting of sugar, from Havana has been discharged at the Government wharf for purposes of disinfection, &c. This wharf and the adjacent warehouse have been very much in need of repairs, and at the time of this writing a new wharf is in course of construction at the station, while the warehouse is also undergoing extensive alterations and improvements.

During the month of September, the new wharf being still unfinished, the bark Cato, from Rio de Janeiro, arrived at the Mississippi River station, having lost a portion of her cargo of coffee and seriously damaged the remainder in the hurricane of September 9. It being a *commercial* as well as a sanitary necessity to discharge the damaged cargo at quarantine, a large grain barge was moored alongside of the vessel. and into this commodious receptacle the coffee was expeditiously and conveniently discharged, fumigation being instituted both in the barge and on the bark, after which the barge was promptly towed to New Orleans, leaving the bark free for purification at leisure. This instance sufficiently shows that the difficulties about insurance, towage, &c., urged against the substitution of the barge system, as advocated by the inspector of the National Board of Health in his reports of last year, for the cumbersome and tedious warehouse system at present in vogue are difficulties that may be made to vanish as by the touch of a magician's wand when the all-powerful interests of commerce chance to be in harmony with those of sanitation.

In conclusion, it is with pleasure that the inspector of the National Board of Health acknowledges his obligations to the State quarantine officers for various official and individual courtesies received at their hands. He has to thank them for co-operating to render his duties as little disagreeable as possible, for their invariable willingness to afford every opportunity for observation, for commodious and independent quarters assigned him, and for the most friendly hospitality at all times.

To refer in passing to certain unfortunate misunderstandings that grew out of the relations between the National Board of Health and the State board of health of Louisiana during the past year, it is gratifying to reflect that, so far as affairs at the Mississippi River quarantine station are concerned, no cause for unpleasantness has arisen this season, and it is to be hoped that the near future has no more of such misunderstandings in store for those whose labors ought to tend harmoniously in the one direction of instituting sanitary reforms and combating pestilence.

The accompanying tables, similar to those sent in with the final report of last year, show the "maritime commerce of New Orleans by the Mississippi River," and a "*résumé* of quarantine work done at the Mississippi River quarantine station" for the year 1881 and for 1882 up to date. A financial statement giving the expense incurred by the National Board of Health inspection service at this station for the season of 1882 is also appended.

Respectfully submitted.

G. FARRAR PATTON, M. D.,
Inspector National Board of Health.

ACCOUNT OF EXPENSES OF NATIONAL BOARD OF HEALTH INSPECTION SERVICE AT MISSISSIPPI RIVER QUARANTINE STATION, SEASON OF 1882.

Pay of inspector, G. F. Patton, from May 15 to September 30, inclusive	$1,668 00
Pay of engineer, W. P. Warder, from May 15 to September 30, inclusive....	341 13
Pay of fireman, Joseph Crawford, from May 15 to July 31, inclusive	63 71
Pay of fireman, Richard Cobden, from August 1 to September 30, inclusive..	50 00
Cost of coal for steam launch from May 15 to September 30 (156 barrels)...	83 90
All other expenses, repairs to machinery of launch, supplies for same, and extra labor.....	78 06
Total	2,284 80

* This is deemed a hasty conclusion, which, instead of admitting "no doubt," does admit of at least the three following, viz: Whether the fumigation, however "powerful," penetrated everywhere and certainly destroyed all infection; whether clothing infected in Havana may not have been unpacked and have infected Forbes after leaving Havana; and whether Forbes may not have been infected by the ballast of the Ile Marthe.—S. E. CHAILLÉ, *Supervising Inspector.*

Statistical table illustrating the maritime commerce of New Orleans by the Mississippi River for the year 1881.

Class of vessels.	JANUARY.						FEBRUARY.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	52	3	35	6	12	108	36	15	20	6	14	91
Total crews each class	1,901	69	413	49	88	2,520	922	336	256	57	106	1,677
Total number of passengers each class	431	....	80	....	4	515	244	8	8	....	3	263
Number of each class quarantined	*1	....	....	....	....	1	.....	....	....	....	....	.....
Number from ports in United States	15	....	4	1	7	27	18	....	1	....	5	24
British North America	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mexico	8	....	2	1	2	13	3	....	....	....	1	4
Central America and Bay Islands	5	....	1	....	1	7	3	....	1	....	8	12
Cuban ports	12	....	4	....	1	17	7	....	1	2	....	10
Other West India islands	1	....	2	....	....	3	1	2	1	....	....	4
North coast South America	.....	....	....	....	....	.....	1	....	....	....	....	1
Rio de Janeiro	.....	....	1	1	1	3	.....	....	7	2	....	9
Other ports on (*a*) E. (*b*) W. coast S. A.	*a* 1	....	*a* 1	....	....	*a* 2	.....	....	....	....	....	.....
British Isles	6	1	....	....	....	7	.....	9	2	....	....	11
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Germany	1	1	....	....	....	2	.....	1	....	....	....	1
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	....	....	....	....	.....	.....	*c* 1	....	....	....	*c* 1
France	.....	....	9	1	....	10	.....	2	5	1	....	8
Spain	1	1	1	1	....	4	3	....	....	....	....	3
Portugal	.....	....	2	....	....	2	.....	....	....	....	1	1
Mediterranean islands	2	....	1	....	....	3	.....	....	....	....	....	.....
Italy	.....	....	2	....	....	2	.....	....	....	....	....	.....
Austria	.....	....	1	....	....	1	.....	....	....	....	....	.....
(*a*) Greece. (*b*) Turkey	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mediterranean Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
West coast of Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) South. (*b*) East coast Africa	.....	....	....	*a* 1	....	*a* 1	.....	....	*a* 2	....	....	*a* 2
British India	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) China. (*b*) Japan	.....	....	....	....	....	.....	.....	....	....	....	....	.....
All other parts of the globe	.....	....	4	....	....	4	.....	....	....	1	....	1

* S. S. Nurnberg, 1 case small-pox.

TONNAGE.—Estimated total for January, 74,900 tons; for February, 63,600 tons.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	March.						April.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	48	10	44	3	9	114	52	10	37	3	16	118
Total crews each class	1,641	197	590	30	63	2,521	1,705	229	482	28	116	2,560
Total number passengers each class	446	9	2	....	4	461	671	....	24	9	21	725
Number of each class quarantined	.....	....	2	....	....	2	.....	....	3	1	....	4
Number from ports in United States	16	....	4	1	1	21	15	1	5	....	3	24
British North America	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
Mexico	8	....	1	1	1	11	8	....	1	....	2	11
Central America and Bay Islands	5	....	.....	....	5	10	6	....	1	....	10	17
Cuban ports	11	....	.....	....	1	12	10	....	4	1	....	15
Other West India islands	1	....	3	1	1	6	2	...	1	....	1	4
North coast South America	.....	....	.....	....	....	.....	1	....	....	....	....	1
Rio de Janeiro	.....	1	4	1	....	6	.....	....	3	1	....	4
Other ports on (*a*) E. (*b*) W. coast S. A.	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
British Isles	4	5	10	....	....	29	5	5	7	....	....	17
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
Germany	.....	....	1	....	....	1	1	2	1	....	....	4
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	*c* 1	*b* 3 *c* 3	....	....	7	*c* 1	....	*c* 2	....	...	*c* 3
France	.....	1	7	....	....	8	.....	4	2	....	....	6
Spain	.....	....	2	....	....	2	1	....	1	....	....	2
Portugal	.....	2	1	....	....	3	.....	....	....	....	....	.....
Mediterranean islands	3	....	.....	....	....	3	1	....	4	....	....	5
Italy	.....	....	2	....	....	2	.....	....	2	1	....	3
Austria	.....	....	1	....	....	1	.....	....	....	....	....	.....
(*a*) Greece. (*b*) Turkey	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
Mediterranean Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
West coast of Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) South. (*b*) East coast Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
British India	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) China. (*b*) Japan	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
All other parts of the globe	.....	....	2	....	....	2	1	....	1	....	....	2

TONNAGE.—Estimated total for March, 81,500 tons; for April, 82,700 tons.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	MAY.						JUNE.						Total for 6 months.
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Number of each class during month	61	8	20	2	16	107	39	4	15	2	15	75	613
Total crews each class	1,683	149	283	16	191	2,322	1,141	69	193	20	97	1,520	13,120
Total number of passengers each class	414	1	6	....	14	435	176	1	7	....	3	187	2,586
Number of each class quarantined	18	1	6	....	....	25	5	2	4	1	2	24	56
Number from ports in United States	22	....	2	1	2	27	12	1	1	....	4	18	141
British North America	1	....	.....	....	....	1	.....	....	....	....	....	.....	1
Mexico	6	....	1	....	1	8	6	1	....	...	1	8	55
Central America and Bay Islands	6	....	.....	....	13	19	4	1	....	....	9	14	79
Cuban ports	9	1	3	....	....	13	7	....	4	....	1	12	79
Other West India islands	.....	....	.....	....	....	.....	1	....	....	....	....	1	18
North coast South America	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	2
Rio de Janeiro	1	....	2	....	....	3	.....	....	....	1	....	1	26
Other ports on (*a*) E. (*b*) W. coast S. A	*a* 1	....	.....	....	....	*a* 1	.....	....	....	....	....	.....	*a*3
British Isles	10	3	6	....	....	19	4	1	3	1	....	9	92
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
Germany	.....	2	.....	....	....	2	1	....	1	....	....	2	12
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	...	*b*1 *c*1	....	....	*b*1 *c*1	.....	....	....	....	....	.....	*b* 4 *c* 9
France	.....	2	3	1	....	6	.....	....	4	....	....	4	42
Spain	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	11
Portugal	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	6
Mediterranean islands	3	....	.....	....	....	3	3	....	....	....	....	3	17
Italy	.....	....	1	....	....	1	.....	....	1	....	....	1	9
Austria	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	1
(*a*) Greece. (*b*) Turkey	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
Mediterranean Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
West coast of Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
(*a*)South. (*b*) East coast Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	*a* 3
British India	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
(*a*) Australia. (*b*) Adjacent islands	*a* 1	....	.....	....	....	*a* 1	.....	....	....	....	....	.....	*a* 1
(*a*) China, (*b*) Japan	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
All other parts of the globe	1	....	.....	....	....	1	1	....	....	....	....	1	11

TONNAGE.—Estimated total for May, 81,000 tons; for June, 52,400 tons; for 6 months, 436,100 tons.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	JULY.						AUGUST.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	37	2	12	1	11	63	29	5	7	....	4	45
Total crews each class	1,206	41	163	8	75	1,493	846	87	89	....	25	1,047
Total number of passengers each class	138	1	4	....	12	155	101	....	5	....	3	109
Number of each class quarantined	8	1	2	1	1	13	7	....	4	....	3	14
Number from ports in United States	13	1	4	....	2	20	13	3	....	....	....	16
British North America	.....	....	....	....	....	.....	....	....	....	....	....	.....
Mexico	5	....	....	1	3	9	3	....	1	....	2	6
Central America and Bay Islands	5	....	....	....	6	11	4	....	....	....	2	6
Cuban ports	2	....	1	....	....	3	4	....	1	....	....	5
Other West India islands	2	....	....	....	....	2	....	....	....	....	....	.....
North coast South America	.....	....	....	....	....	.....	....	....	....	....	....	.....
Rio de Janeiro	.....	1	1	....	....	2	....	....	2	....	....	2
Other ports on (*a*) E. (*b*) W. coast S. A.	.....	....	....	....	....	.....	....	....	....	....	....	.....
British Isles	11	....	2	....	....	13	5	....	....	....	....	5
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	....	....	....	.....	....	....	....	....	....	.....
Germany	.....	....	....	....	....	.....	....	1	....	....	....	1
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	....	*c*2	....	....	*c*2	....	....	*c*1	....	....	*c*1
France	.....	....	2	....	....	2	....	1	2	....	....	3
Spain	.....	....	....	....	....	.....	....	....	....	....	....	.....
Portugal	.....	....	....	....	....	.....	....	....	....	....	....	.....
Mediterranean islands	.....	....	....	....	....	.....	....	....	....	....	....	.....
Italy	.....	....	....	....	....	.....	....	....	....	....	....	.....
Austria	.....	....	....	....	....	.....	....	....	....	....	....	.....
(*a*) Greece. (*b*) Turkey	.....	....	....	....	....	.....	....	....	....	....	....	.....
Mediterranean Africa	.....	....	....	....	....	.....	....	....	....	....	....	.....
West coast of Africa	.....	....	....	....	....	.....	....	....	....	....	....	.....
(*a*) South. (*b*) East coast Africa	.....	....	....	....	....	.....	....	....	....	....	....	.....
British India	.....	....	....	....	....	.....	....	....	....	....	....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	....	....	....	.....	....	....	....	....	....	.....
(*a*) China. (*b*) Japan	.....	....	....	....	....	.....	....	....	....	....	....	.....
All other parts of the globe	.....	....	....	....	....	.....	....	....	....	....	....	.....

TONNAGE.—Estimated total for July, 46,300 tons; for August, 37,900 tons.

Class of vessels.	SEPTEMBER.						OCTOBER.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	36	5	7	3	9	59	60	8	7	1	11	87
Total crews each class	1,097	100	84	23	64	1,368	2,078	148	97	8	74	2,405
Total number of passengers each class	182	2	2	1	2	189	1,993	1	....	....	2	1,996
Number of each class quarantined	7	1	2	1	2	13	22	1	2	....	....	25
Number from ports in United States	17	2	3	1	....	23	25	....	1	....	....	25
British North America	....	....	....	....	....	....	....	....	....	....	....	....
Mexico	3	....	....	....	2	5	8	....	....	....	....	8
Central America and Bay islands	4	....	....	....	7	11	7	....	....	1	11	19
Cuban ports	3	....	1	....	....	4	11	....	1	....	....	12
Other West India islands	1	....	....	1	....	2	2	....	....	....	....	2
North coast South America	1	....	....	....	....	1	....	....	....	....	....	....
Rio de Janeiro	....	....	1	1	....	2	2	1	1	....	....	3
Other ports on (*a*) E. (*b*) W. coast S. A.	....	....	....	....	....	....	....	....	....	....	....	....
British Isles	7	3	....	....	....	10	4	2	1	....	....	7
(*a*) Norway. (*b*) Sweden. (*c*) Russia	....	....	....	....	....	....	....	....	....	....	....	....
Germany	....	....	....	....	....	....	1	3	1	....	....	5
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	....	....	*c*1	....	....	*c*1	....	*c*1	*c*1	....	....	*c*2
France	....	....	1	....	....	1	....	....	....	....	....	....
Spain	....	....	....	....	....	....	....	....	....	....	....	....
Portugal	....	....	....	....	....	....	....	....	....	....	....	....
Mediterranean islands	....	....	....	....	....	....	....	....	....	....	....	....
Italy	....	....	....	....	....	....	....	....	....	....	....	....
Austria	....	....	....	....	....	....	....	....	....	....	....	....
(*a*) Greece. (*b*) Turkey	....	....	....	....	....	....	....	....	....	....	....	....
Mediterranean Africa	....	....	....	....	....	....	....	....	....	....	....	....
West coast of Africa	....	....	....	....	....	....	....	....	....	....	....	....
(*a*) South. (*b*) East coast Africa	....	....	....	....	....	....	....	....	....	....	....	....
British India	....	....	....	....	....	....	....	....	....	....	....	....
(*a*) Australia. (*b*) Adjacent islands	....	....	....	....	....	....	....	....	....	....	....	....
(*a*) China. (*b*) Japan	....	....	....	....	....	....	....	....	....	....	....	....
All other parts of the globe	....	....	....	....	....	....	....	....	....	....	....	....

TONNAGE.—Estimated total for September, 46,000 tons; for October, 72,800 tons.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	November.						December.						Total for 12 months.
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Number of each class during month	47	14	18	2	9	90	43	5	25	2	11	85	1,048
Total crews each class	1,502	266	236	17	57	2,078	1,566	97	326	10	80	2,079	23,590
Total number of passengers each class	1,247	9	1	....	4	1,261	437	3	3	....	5	448	6,744
Number of each class quarantined	.....	....	.....	....	....	.....	.....	....	....	1	....	1	122
Number from ports in United States	16	3	3	1	1	24	21	....	3	....	6	30	240
British North America	.....	....	.....	....	....	.....	....	....	....	....	....	.....	1
Mexico	5	....	.....	....	2	7	7	....	2	....	....	9	99
Central America and Bay Islands	6	....	.....	....	5	6	5	....	....	....	4	9	141
Cuban ports	12	....	2	1	....	20	7	....	2	....	....	9	132
Other West India islands	4	....	.....	....	1	5	1	....	2	....	1	.....	33
North coast South America	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	3
Rio de Janeiro	.....	1	2	....	....	3	.....	1	5	1	....	7	45
Other ports on (*a*) E. (*b*) W. coast S. A	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	3
British Isles	3	3	.....	....	....	6	2	3	2	....	....	7	140
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
Germany	1	2	1	....	....	4	.....	....	1	....	....	1	23
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	*c*3	*b*1 *c*2	....	....	*b*1 *c*5	.....	*c*1	*c*1	....	....	*c*2	27
France	.....	1	4	....	....	5	.....	....	....	....	....	3	58
Spain	.....	....	.....	....	....	.....	.....	....	2	....	....	2	13
Portugal	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	6
Mediterranean Islands	.....	....	.....	....	....	.....	.....	...	....	...	....	.....	17
Italy	.....	1	1	....	....	2	.....	....	....	....	....	.....	11
Austria	.....	...	.....	....	....	.....	.....	....	....	....	....	.....	1
(*a*) Greece. (*b*) Turkey	.....	....	.....	....	....	.....	.....	....	...	....	....	.....	.....
Mediterranean Africa	.....	....	1	....	....	1	.....	....	....	....	....	.....	1
West coast of Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
(*a*) South. (*b*) East coast Africa	.....	....	.....	....	....	.....	.....	....	*a*1	....	....	*a*1	4
British India	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	1
(*a*) China. (*b*) Japan	.....	....	.....	....	....	.....	.....	....	....	....	....	.....	.....
All other parts of the globe	.....	....	1	....	....	1	.....	....	1	....	....	1	13
Total number of vessels of each class for 12 months	.....	....	.....	....	....	.....	544	92	244	34	134	1,048	.....

TONNAGE.—Estimated total for November, 71,300 tons; for December, 62,000; for 12 months, 773,600 tons.

Statistical table giving résumé of quarantine work done at Mississippi River Station, for the year 1881.

Class of vessels.	JANUARY.						FEBRUARY.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month	52	3	35	6	12	108	36	15	20	6	14	91
Number of each class detained in quarantine	*1	....	....	....	....	1	...	....	....	....	....	....
Number of each class infected on arrival	*1	....	....	....	....	1	....	....	....	....	....	....
Number of each class developing infect. disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	85	....	....	....	....	85	....	....	....	....	....	....
Aggregate of passengers of quarantined vessels	173	....	....	....	....	173	....	....	....	....	....	....
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 2 to 4 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	...	....	....	....	....	....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....
While in quarantine:												
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	*1	....	....	....	....	1	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other Cuban ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other West India Islands	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Vera Cruz	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from other Mexican or Central American ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other countries	*1	....	....	....	....	1	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

*S. S. Nurnberg, from Bremen.

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	March.						April.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month	48	10	44	3	9	114	52	10	37	3	16	118
Number of each class detained in quarantine	....	....	2	....	....	....	....	....	3	1	....	4
Number of each class infected on arrival	....	....	....	....	....	....	....	....	2	1	....	3
Number of each class developing infect. disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	....	....	16	....	....	16	....	....	32	8	....	40
Aggregate of passengers of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 2 to 4 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	1	....	....	1
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	2	1	....	3
While in quarantine:												
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other Cuban ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other West India Islands	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Vera Cruz	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other Mexican or Central American ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	MAY.						JUNE.						Total for 6 months.
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Total number of each class arriving during month	61	8	20	2	16	107	39	4	15	2	15	75	613
Number of each class detained in quarantine	18	1	6	....	....	25	15	2	4	1	2	24	56
Number of each class infected on arrival	....	....	....	....	....	....	....	....	....	....	....	....	3
Number of each class developing infect. disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	665	16	76	....	....	757	499	35	65	9	15	623	1521
Aggregate of passengers of quarantined vessels	308	....	6	....	....	314	89	1	6	....	2	98	585
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	..	2
Number of each class detained 2 to 4 days	17	....	5	....	....	22	14	2	5	1	2	24	46
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class detained 10 to 12 days	1	....	....	....	....	1	....	....	....	....	....	....	2
Number of each class detained 12 to 15 days and over	....	....	1	....	....	1	....	....	....	1	....	1	7
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
While in quarantine :													
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class quarantined from Havana	3	....	3	..	....	6	6	....	3	....	....	9	15
Number of each class quarantined from other Cuban ports	6	1	....	....	....	7	1	....	1	....	1	3	10
Number of each class quarantined from other West India Islands	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class quarantined from Vera Cruz	6	....	....	....	....	6	5	1	....	....	1	7	13
Number quarantined from other Mexican or Central American ports	1	....	1	....	....	2	3	1	1	....	....	5	7
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	....	1	....	1	10
Number quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....	1
Number quarantined from all other countries	....	....	....	....	....	....	....	....	....	..	....	....	1
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....	.....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	July.						August.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month	37	2	12	1	11	63	29	5	7	....	4	45
Number of each class detained in quarantine....	8	1	2	1	1	13	7	....	4	....	3	14
Number of each class infected on arrival	....	....	....	....	....	....	....	....	*1	....	....	1
Number of each class developing infect. disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	318	18	18	10	5	374	266	....	45	....	17	328
Aggregate of passengers of quarantined vessels.	11	1	....	....	....	12	12	....	....	....	....	12
Number of each class detained 1 to 2 days.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 2 to 4 days.....	....	....	....	....	1	1	....	....	....	....	....	....
Number of each class detained 4 to 6 days.....	....	....	....	....	....	....	....	....	1	....	1	2
Number of each class detained 6 to 8 days.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days.....	8	....	1	....	....	9	6	....	....	....	1	7
Number of each class detained 10 to 12 days.....	....	1	....	1	....	2	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	1	....	....	1	1	....	2	....	....	3
While in quarantine :												
Number of cases of yellow fever on vessels....	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Nmber of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels.	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels....	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels....	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels....	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana.	1	....	....	....	....	1	....	....	1	....	....	1
Number of each class quarantined from other Cuban ports	1	....	1	....	....	2	4	....	....	....	....	4
Number of each class quarantined from other West India Islands.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Vera Cruz	6	....	....	1	....	7	2	....	....	....	....	2
Number quarantined from other Mexican or Central American ports.....	....	....	....	....	1	1	1	....	1	....	3	5
Number of each class quarantined from Rio de Janeiro	....	1	1	....	....	2	....	....	2	....	....	2
Number quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other countries ...	....	....	....	....	....	....	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

*Bark Espana from Havana.

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	September.						October.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month	36	5	7	3	9	59	60	8	7	1	11	87
Number of each class detained in quarantine	7	1	2	1	2	13	22	1	2	....	....	25
Number of each class infected on arrival	....	....	*1	....	....	1	....	....	....	....	....	....
Number of each class developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	263	18	28	9	15	333	801	22	29	....	....	852
Aggregate of passengers of quarantined vessels	54	....	....	1	2	57	396	....	....	....	....	396
Number of each class detained 1 to 2 days	1	1	....	....	1	3	1	....	....	....	....	1
Number of each class detained 2 to 4 days	....	....	....	....	....	....	18	....	1	....	....	19
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	1	....	....	....	1
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days	6	....	1	1	1	9	3	....	1	....	....	4
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....
While in quarantine:												
Number of cases of yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana	2	....	1	....	....	3	3	....	1	....	....	4
Number of each class quarantined from other Cuban ports	1	....	....	....	....	1	8	....	....	....	....	8
Number of each class quarantined from other West India islands	1	....	....	....	....	1	1	....	....	....	....	1
Number of each class quarantined from Vera Cruz	2	....	....	....	1	3	7	....	....	....	....	7
Number of each class quarantined from other Mexican or Central American ports	1	....	....	....	1	2	1	....	....	....	....	1
Number of each class quarantined from Rio de Janeiro	....	....	1	1	....	2	2	1	1	....	....	4
Number of each class quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other countries	....	1	....	....	....	1	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

* Bark Christina, from Havana.

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	November.						December.						Total for 12 months.
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Total number of each class arriving during month	47	14	18	2	9	90	43	5	25	2	10	85	1048
Number of each class detained in quarantine	....	....	....	....	....	....	....	....	1	....	....	1	122
Number of each class infected on arrival	....	....	....	....	....	....	....	....	1	....	....	1	6
Number of each developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....	.....
Aggregate of crews of quarantined vessels	....	....	....	....	....	....	....	....	12	....	....	12	3474
Aggregate of passengers of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....	1062
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	....	6
Number of each class detained 2 to 4 days	....	....	....	....	....	....	....	....	1	....	....	....	66
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....	3
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....	29
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....	4
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....	11
While in quarantine:													
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of ——— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of ——— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of ——— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from ——— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from ——— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from ——— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class quarantined from Havana	....	....	....	....	....	....	....	....	....	....	....	....	24
Number of each class quarantined from other Cuban ports	....	....	....	....	....	....	....	....	....	....	....	....	25
Number of each class quarantined from other West India islands	...	....	....	....	....	....	....	....	....	....	....	....	2
Number of each class quarantined from Vera Cruz	....	....	....	....	....	....	....	....	....	....	....	....	32
Number of each class quarantined from other Mexican or Central American ports	....	....	....	....	....	....	....	....	....	....	....	....	16
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	1	....	....	1	21
Number of each class quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....	1
Number of each class quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....	2
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....	.....

Statistical table illustrating the maritime commerce of New Orleans by the Mississippi River for the year 1882.

Class of vessels.	JANUARY.						FEBRUARY.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	46	6	25	3	8	88	36	7	9	3	10	65
Total crews of each class	1,525	125	341	27	55	2,073	1,243	120	123	29	66	1,581
Total number of passengers of each class	298	1	88	....	2	389	535	2	13	....	1	550
Number of each class quarantined.	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
Number from—												
Ports in the United States	15	....	4	....	1	20	8	2	2	....	2	14
British North America	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
Mexico	6	....	1	....	1	8	6	....	....	....	...	6
Central America and Bay Islands	5	....	.....	....	2	7	5	....	....	....	7	12
Cuban ports	12	....	3	1	....	16	7	....	2	2		11
Other West India islands	2	....	1	1	4	8	1	....	....	....	1	2
North coast of South America	.....	....	1	....	....	1	.....	....	....	...	....	.....
Rio de Janeiro	1	....	5	1	....	7	.....	1	...	1	....	2
Other ports on (*a*) east. (*b*) West coast South America	.....	....	.....	....	....	.....	.....	...	....	....	....	.....
British Isles	3	5	1	....	....	9	7	3	....	...	...	10
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	*a*1	....	....	*a*1	.....	....	....	....	....	.....
Germany	.....	....	.....	....	....	.....	.....	....	2	....	....	2
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	*c*1	*b*1 *c*1	....	....	*b*1 *c*2	.....	*c*1	....	....	....	*c*1
France	.....	....	3	....	....	3	.....	....	....	....	....	.....
Spain	1	....	.....	....	....	1	.....	....	....	....	....	.....
Portugal	.....	....	1	....	....	1	.....	....	....	....	....	.....
Mediterranean islands	1	....	1	....	....	2	2	....	2	....	....	4
Italy	.....	....	1	....	....	1	.....	....	1	....	....	1
Austria	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) Greece. (*b*) Turkey	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
Mediteranean Africa	.....	....	.....	....	....	.....	.....	....	....	....	...	.....
West coast of Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) South. (*b*) East coast of Africa	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
British India	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
(*a*) China. (*b*) Japan	.....	....	.....	....	....	.....	.....	....	....	....	....	.....
All other parts of the globe	.....	....	.....	....	....	.....	.....	....	....	....	....	.....

TONNAGE.—Estimated total for January, 64,900; for February, 49,100.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	March.						April.					
	Steam ships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	42	9	25	8	14	98	59	2	9	1	22	93
Total crews of each class	1,806	170	305	81	95	2,357	2,655	35	121	7	154	2,972
Total number of passengers of each class	333	1	6	1	1	342	929	....	3	....	7	939
Number of each class quarantined	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Number from—												
Ports in the United States	12	....	3	1	1	17	32	....	....	1	9	42
British North America	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mexico	5	....	1	....	4	10	5	....	....	....	3	8
Central America and Bay Islands	4	....	....	....	8	12	5	....	....	....	9	14
Cuban ports	14	1	5	5	1	26	10	....	3	....	....	13
Other West India islands	2	....	....	....	....	2	2	....	....	....	1	3
North coast of South America	.....	....	1	2	....	3	.....	....	....	....	....	.....
Rio de Janeiro	.....	1	....	....	....	1	.....	....	1	....	....	1
Other ports on (*a*) east. (*b*) West coast of South America	.....	....	....	....	....	.....	.....	....	....	....	....	.....
British Isles	2	3	5	....	....	10	3	2	1	....	....	6
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	....	....	....	.....	.....	....	*b*1	....	....	*b*1
Germany	.....	1	1	....	....	2	.....	....	....	....	....	.....
(*a*) Denmark. (*b*) Hollond. (*c*) Belgium	*c*1	....	....	....	....	*c*1	.....	....	*c*1	....	....	*c*1
France	.....	3	4	....	....	7	.....	....	1	....	....	1
Spain	.....	....	1	....	....	1	1	....	....	....	....	1
Portugal	.....	....	1	....	....	1	.....	....	1	....	....	1
Mediterranean Islands	2	....	1	....	....	3	1	....	....	....	....	1
Italy	.....	....	2	....	....	2	.....	....	....	....	....	.....
Austria	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) Greece. (*b*) Turkey	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mediterranean Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
West coast of Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) South. (*b*) East coast of Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
British India	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) China. (*b*) Japan	.....	....	....	....	....	.....	.....	....	....	....	....	.....
All other parts of the globe	.....	....	....	....	....	.....	.....	....	....	....	....	.....

TONNAGE.—Estimated total for March, 66,500; for April, 67,900.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	MAY.						JUNE.						Total for 6 months.
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Number of each class during month	52	5	10	....	14	81	31	2	12	3	15	63	488
Total crews of each class	1,530	103	124	....	102	1,859	963	37	153	27	103	1,283	12,125
Total number of passengers of each class	554	3	5	....	4	566	287	....	7	....	5	299	3,085
Number of each class quarantined	12	....	3	....	1	16	11	1	6	3	1	22	38
Number from—													
Ports in the United States	25	1	2	....	5	33	15	....	1	....	2	18	144
British North America	.....	....	1	....	....	1	....	....	....	....	....	.....	1
Mexico	8	....	....	....	2	10	6	....	....	....	5	11	53
Central America and Bay Islands	8	....	....	....	7	15	5	1	....	....	7	13	73
Cuban ports	5	....	2	....	....	7	3	....	5	1	....	9	82
Other West India islands	2	....	....	....	....	2	1	...	....	....	1	2	19
North coast of South America	.....	....	....	....	....	.....	....	....	....	....	....	.....	4
Rio de Janeiro	.....	....	1	....	....	1	....	....	1	2	....	3	15
Other ports on (*a*) east. (*b*) West coast of South America	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
British Isles	3	3	3	....	....	9	1	1	1	....	....	3	47
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	....	....	....	.....	....	....	....	....	....	.....	2
Germany	.....	1	....	....	....	1	....	....	....	....	....	.....	5
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	....	....	....	....	.....	....	....	....	....	....	.....	6
France	.....	....	1	....	....	1	....	....	2	....	....	2	14
Spain	.....	....	....	....	....	.....	....	....	....	....	....	.....	3
Portugal	.....	....	....	....	....	.....	....	....	....	....	....	.....	3
Mediterranean islands	1	...	....	...	....	1	....	....	....	....	....	...	11
Italy	.....	....	....	....	....	.....	....	....	2	....	....	2	6
Austria	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
(*a*) Greece. (*b*) Turkey	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
Mediterranean Africa	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
West coast of Africa	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
(*a*) South. (*b*) East coast of Africa	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
British India	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
(*a*) China. (*b*) Japan	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
All other parts of the globe	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....
Total number of vessels of each class for six months	.....	....	....	....	....	.....	....	....	....	....	....	.....	.....

TONNAGE.—Estimated total for May, 63,400; for June, 41,100; for six months, 352,900.

Statistical table illustrating the maritime commerce of New Orleans—Continued.

Class of vessels.	July.						August.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month	25	3	4	1	9	42	45	3	5	....	7	60
Total crews of each class	855	47	45	11	67	1,025	1,250	50	58	....	50	1,408
Total number of passengers of each class	209	1	....	7	3	220	78	....	1	....	3	82
Number of each class quarantined	6	....	1	....	2	9	13	....	....	....	1	14
Number from—												
Ports in the United States	12	2	2	....	2	18	14	1	4	....	2	21
British North America	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mexico	1	....	....	....	1	2	6	....	....	....	....	6
Central America and Bay Islands	5	....	....	....	4	9	7	....	....	....	4	11
Cuban ports	3	....	1	....	2	6	4	....	....	....	1	5
Other West India islands	2	....	....	....	....	2	5	....	....	....	....	5
North coast of South America	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Rio de Janeiro	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Other ports on (*a*) east. (*b*) West coast of South America	.....	....	....	....	....	.....	.....	....	....	....	....	.....
British Isles	1	1	1	....	....	3	8	1	1	....	....	10
(*a*) Norway. (*b*) Sweden. (*c*) Russia	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Germany	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) Denmark. (*b*) Holland. (*c*) Belgium	.....	....	....	....	....	.....	.....	....	....	....	....	.....
France	.....	....	....	....	....	.....	.....	1	....	....	....	1
Spain	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Portugal	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mediterranean islands	1	....	....	1	....	2	1	....	....	....	....	1
Italy	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Austria	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) Greece. (*b*) Turkey	.....	....	....	....	....	.....	.....	....	....	....	....	.....
Mediterranean Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
West coast of Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) South. (*b*) East coast of Africa	.....	....	....	....	....	.....	.....	....	....	....	....	.....
British India	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) Australia. (*b*) Adjacent islands	.....	....	....	....	....	.....	.....	....	....	....	....	.....
(*a*) China. (*b*) Japan	.....	....	....	....	....	.....	.....	....	....	....	....	.....
All other parts of the globe	.....	....	....	....	....	.....	.....	....	....	....	....	.....

TONNAGE.—Estimated total for July, 31,100; for August, 51,200.

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	September.						October.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Number of each class during month												
Total crews of each class												
Total number of passengers of each class												
Number of each class quarantined												
Number from—												
Ports in the United States												
British North America												
Mexico												
Central America and Bay Islands												
Cuban ports												
Other West India islands												
North coast of South America												
Rio de Janeiro												
Other ports on (*a*) east. (*b*) West coast of South America												
British Isles												
(*a*) Norway. (*b*) Sweden. (*c*) Russia												
Germany												
(*a*) Denmark. (*b*) Holland. (*c*) Belgium												
France												
Spain												
Portugal												
Mediterranean islands												
Italy												
Austria												
(*a*) Greece. (*b*) Turkey												
Mediterranean Africa												
West coast of Africa												
(*a*) South. (*b*) East coast of Africa												
British India												
(*a*) Australia. (*b*) Adjacent islands												
(*a*) China. (*b*) Japan												
All other parts of the globe												

Statistical table illustrating the maritime commerce of New Orleans, &c.—Continued.

Class of vessels.	November.						December.						Total for 12 months.
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Number of each class during month													
Total crews of each class													
Total number of passengers of each class													
Number of each class quarantined													
Number from—													
Ports in the United States													
British North America													
Mexico													
Central America and Bay Islands													
Cuban ports													
Other West India islands													
North coast of South America													
Rio de Janeiro													
Other ports on (*a*) east. (*b*) West coast of South America													
British Isles													
(*a*) Norway. (*b*) Sweden. (*c*) Russia													
Germany													
(*a*) Denmark. (*b*) Holland. (*c*) Belgium													
France													
Spain													
Portugal													
Mediterranean islands													
Italy													
Austria													
(*a*) Greece. (*b*) Turkey													
Mediterranean Africa													
West coast of Africa													
(*a*) South. (*b*) East coast of Africa													
British India													
(*a*) Australia. (*b*) Adjacent islands													
(*a*) China. (*b*) Japan													
All other parts of the globe													
Total number of vessels of each class for twelve months													

Statistical table giving résumé of quarantine work done at Mississippi River Station for the year 1882.

Class of vessels.	JANUARY.						FEBRUARY.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month.	46	6	25	3	8	88	36	7	9	3	10	65
Number of each class detained in quarantine	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class infected on arrival	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of passengers of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 2 to 4 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....
While in quarantine:												
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number or cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other Cuban ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other West India islands	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Vera Cruz	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from other Mexican and Central American ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	March.						April.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month.	42	9	25	8	14	98	59	2	9	1	22	93
Number of each class detained in quarantine	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class infected on arrival	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of passengers of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 2 to 4 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....
While in quarantine:												
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other Cuban ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other West India islands	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Vera Cruz	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from other Mexican and Central American ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	MAY.						JUNE.						
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Total number of each class arriving during month	52	5	10	....	14	81	31	2	12	3	15	63	.....
Number of each class detained in quarantine	12	....	3	....	1	16	11	1	6	3	1	22	.....
Number of each class infected on arrival	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....	.....
Aggregate of crews of quarantined vessels	389	....	38	....	7	434	400	18	78	27	8	531	.....
Aggregate of passengers of quarantined vessels	126	....	1	....	1	128	185	....	4	....	....	189	.....
Number of each class detained 1 to 2 days	....	....	....	....	....	....	2	1	....	....	....	3	.....
Number of each class detained 2 to 4 days	12	....	3	....	....	15	9	....	5	1	....	15	.....
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	2	....	2	.....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	1	1	.....
Number of each class detained 8 to 10 days	....	....	....	....	1	1	....	....	....	....	....	....	.....
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	1	....	....	1	.....
While in quarantine:													
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of —— on vessels	....	....	....	....	1	1	....	....	....	....	2	2	.....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from —— from vessels	....	....	....	....	1	1	....	....	....	....	1	1	.....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class quarantined from Havana	4	....	2	....	....	6	2	....	5	1	....	8	.....
Number of each class quarantined from other Cuban ports	1	....	....	....	....	....	1	....	....	....	....	....	.....
Number of each class quarantined from other West India islands	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number of each class quarantined from Vera Cruz	5	....	....	....	....	5	6	....	....	....	....	6	.....
Number quarantined from other Mexican and Central American ports	2	....	....	....	1	3	2	1	....	....	1	4	.....
Number of each class quarantined from Rio de Janeiro	....	....	1	....	....	1	....	....	1	2	....	3	.....
Number quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....	.....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....	.....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	July.						August.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month.	25	3	4	1	9	42	45	3	5	....	7	60
Number of each class detained in quarantine	6	....	1	....	2	9	13	....	....	....	1	14
Number of each class infected on arrival	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	351	....	14	....	14	379	428	....	....	....	7	435
Aggregate of passengers of quarantined vessels.	3	....	....	....	....	3	3	....	....	....	3	6
Number of each class detained 1 to 2 days	....	....	....	....	....	....	1	....	....	....	....	1
Number of each class detained 2 to 4 days	2	....	....	....	....	2	2	....	....	....	....	2
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days	4	....	1	....	2	7	10	....	..	....	1	11
Number of each class detained 10 to 12 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....
While in quarantine:												
Number of cases of yellow fever on vessels..	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	...	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels.....	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels..	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels..	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels..	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana.	1	....	1	....	2	4	2	....	....	....	....	2
Number of each class quarantined from other Cuban ports	2	....	....	....	....	2	2	....	....	....	1	3
Number of each class quarantined from other West India Islands	1	....	...	....	....	1	1	....	....	....	....	1
Number of each class quarantined from Vera Cruz	1	....	....	....	....	1	6	....	....	....	....	....
Number quarantined from other Mexican and Central American ports.....	1	....	....	....	....	1	2	....	....	....	....	....
Number of each class quarantined from Rio de-Janeiro	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....
Number developing infectious disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	September.						October.					
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.
Total number of each class arriving during month	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained in quarantine	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class infected on arrival	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class developing infectious disease after arrival	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of crews of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Aggregate of passengers of quarantined vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 1 to 2 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 2 to 4 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 4 to 6 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 6 to 8 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 8 to 10 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 10 to 13 days	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class detained 12 to 15 days and over	....	....	....	....	....	....	....	....	....	....	....	....
While in quarantine:												
Number of cases of yellow fever on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of small-pox on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of cases of —— on vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from yellow fever from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from small-pox from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from —— from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of deaths from — from vessels	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Havana	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other Cuban ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from other West India Islands	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Vera Cruz	....	....	....	....	....	....	....	....	....	....	....	....
Number quarantined from other Mexican and Central American ports	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from Rio de Janeiro	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other ports in South America	....	....	....	....	....	....	....	....	....	....	....	....
Number of each class quarantined from all other countries	....	....	....	....	....	....	....	....	....	....	....	....
Number developing infection disease in New Orleans	....	....	....	....	....	....	....	....	....	....	....	....

Statistical table giving résumé of quarantine work done, &c.—Continued.

Class of vessels.	November.						December.						
	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Total.	
Total number of each class arriving during month													
Number of each class detained in quarantine													
Number of each class infected on arrival													
Number of each class developing infectious disease after arrival													
Aggregate of crews of quarantined vessels													
Aggregate of passengers of quarantined vessels													
Number of each class detained 1 to 2 days													
Number of each class detained 2 to 4 days													
Number of each class detained 4 to 6 days													
Number of each class detained 6 to 8 days													
Number of each class detained 8 to 10 days													
Number of each class detained 10 to 12 days													
Number of each class detained 12 to 15 days and over													
While in quarantine:													
Number of cases of yellow fever on vessels													
Number of cases of small-pox on vessels													
Number of cases of —— on vessels													
Number of cases of —— on vessels													
Number of cases of —— on vessels													
Number of deaths from yellow fever from vessels													
Number of deaths from small-pox from vessels													
Number of deaths from —— from vessels													
Number of deaths from —— from vessels													
Number of deaths from —— from vessels													
Number of each class quarantined from Havana													
Number of each class quarantined from other Cuban ports													
Number of each class quarantined from other West India Islands													
Number of each class quarantined from Vera Cruz													
Number quarantined from other Mexican and Central American ports													
Number of each class quarantined from Rio de Janeiro													
Number of each class quarantined from all other ports in South America													
Number of each class quarantined from all other countries													
Number developing infectious disease in New Orleans													

FINAL REPORT FOR THE FOUR AND A HALF MONTHS, MAY 15 TO SEPTEMBER 30, 1882, INCLUSIVE. RIVER INSPECTION SERVICE, NATIONAL BOARD OF HEALTH.

NEW ORLEANS, *October* 1, 1882.

Dr. STANFORD E. CHAILLÉ,
Supervising Inspector:

SIR: We respectfully submit for your consideration this our final report of the river inspection service, as carried on by us for the past four months and a half:

Number of steamboats inspected		146
Tonnage	128,025.59	
Number of persons thereon, including officers, crews, and passengers, about	11,517	
Number of barges inspected		112
Tonnage about	168,000	
Number of other river craft inspected		4
Number of coal-boats, &c., not requiring inspection	29	
Total number of river craft inspected		262

In addition to the inspection of river craft, we have, as last year, given considerable time to obtaining—

1st. The daily record of entrances of vessels at the custom-house.

2d. The daily mortuary report from the books of the State board of health.

We have nothing to add to the remarks in our final report of last year concerning the general value of the inspection service. The officers and agents of river craft have extended us the same courtesies and facilities, and shown, with some exceptions, the same readiness as heretofore in carrying out the rules and regulations of the service.

It is proper, however, to state that three boats left without certificates of inspection, having failed to notify us of their intended departure. One of these, the tug Clarence, for Memphis, accepted the certificate of the Marine Hospital Service. She was, as reported in the newspapers, fined by the local authorities of Memphis for not having the certificate of the National Board of Health.

We know of nothing else of sufficient importance to demand notice in this report.

P. B. McCUTCHON, M. D.,
F. W. PARHAM, M. D.,
Inspectors, National Board of Health.

NATIONAL BOARD OF HEALTH, RAILROAD INSPECTION SERVICE,
New Orleans, La., October 1, 1882.

Report of inspections at Chicago, Saint Louis and New Orleans Railroad, from June 30, 1882 *(date of commencement of service), to September* 30, 1882, *inclusive.*

	July, including June 30.	August.	September.	Total.
Number of loaded freight cars inspected	1,033	535	984	2,552
Number of empty freight cars inspected	865	740	933	2,537
Number of freight trains inspected	78	72	67	207
Number of persons thereon	390	360	285	1,035
Number of bales, rags, and paper stock carried	273	172	43	488
Number of cars containing same	15	9	2	26
Number of trains carrying same	7	5	2	14
Total number freight cars leaving New Orleans	1,897	1,275	1,917	5,089

The rags and paper stock enumerated above were shipped in *through* cars to be carried to destination with unbroken seals.

At the request of the management of the road, I began on July 16 to issue separate special certificates for each car destined for Memphis, Tenn. One hundred and forty-five of said certificates were issued to that number of loaded cars. The wisdom of this action as well as the utility of the inspection service was demonstrated by the fact that not one pound of freight shipped for Memphis was delayed or refused transpor-

tation, and that without these certificates no freight from New Orleans would have been allowed to enter that city.

Such materials as hides, wool, "glue stock," &c., were under my direction shipped in through sealed cars, and attention called to the fact by proper indorsement on the certificate of inspection which accompanied the train. With the above precautions there was no interruption to the carrying of freight.

The officials of the railroad company offered every facility for the proper performance of my duties, and were uniformly courteous, and ready to act upon and carry out any suggestions in regard to the transportation of freight and the proper sanitary condition of cars, depots, &c.

Very respectfully,

L. F. SALAMON, M. D.,
Inspector.

Dr. S. E. CHAILLÉ,
Supervising Inspector, National Board of Health.

NATIONAL BOARD OF HEALTH, RAILROAD INSPECTION SERVICE,
New Orleans, La., October 1, 1882.

Report of inspection at Louisville and Nashville Railroad, from June 30, *date of commencement of service, to September* 30, *inclusive.*

	July.*	August.	September.	Total.
Number of loaded freight cars inspected	886	778	821	2,485
Number of empty freight cars inspected	453	742	1,349	2,544
Number of freight trains inspected	61	62	73	196
Number of persons thereon	366	372	425	1,163
Number of bales of rags and paper stock	158	93	41	292
Number of cars containing same	8	4	4	16
Number of trains carrying same	7	3	4	14
Total cars leaving New Orleans	1,339	1,520	2,170	5,029

* Including one day in June.

The rags and paper stock above mentioned were shipped in sealed cars to points of destination.

It is difficult, in making this report, to add anything to the suggestions already made, relative to this service, in my first report.

After the observation and experience of another year we may confidently assert that sufficient has been accomplished to show its value in allaying fear and preventing injurious quarantine during a period of apprehension of the existence of yellow fever, but the crucial test of its utility has not yet been made, owing to the non-existence of yellow fever in this city since the service was inaugurated. Whether a careful inspection of freights would guarantee protection against infection from this source to other localities, or whether the confidence of adjoining communities would be commanded in a time of great danger, to such an extent as to prevent serious interference with commerce, can alone be determined when the hour of peril comes. These are certainly the great objects which it is intended to accomplish, and anything which falls short of this fails to meet the obligations required of such a service, but should it accomplish this there is no branch of health or municipal authority capable of exercising a more powerful influence, to guard against all the disasters of a "fever" panic. The authorities of this railroad, and especially the superintendent, Mr. J. T. Harahan, manifest great interest in the health and sanitary condition of New Orleans, and are earnest supporters of a judicious system of quarantine, to what extent may be inferred from the willingness with which they incur the expense of the salary of the inspector.

It is evident that this service has already resulted in good, and to what extent it may prove of benefit can only be determined in case of the occurrence of the yellow fever.

Respectfully submitted.

J. M. WATKINS, M. D.,
Inspector, National Board of Health.

Dr. S. E. CHAILLÉ,
Supervising Inspector, National Board of Health.

NEW ORLEANS, LA., *September* 30, 1882.

Dr. S. CHAILLÉ,
Supervising Inspector, National Board of Health, New Orleans, La.:

SIR: I have the honor to forward you my first monthly report, ending September 30, 1882.

The following were the number of passengers weekly to the State of Mississippi, on Chicago, Saint Louis and New Orleans Railroad—two trains daily:

Week ending September 10	286
Week ending September 17	433
Week ending September 24	424
Week ending September 30	396
Total for four weeks	1,539

The excursion trains every Sunday morning, each containing nearly 300 passengers, were regularly inspected.

Very respectfully,

S. C. RUSSELL, M. D.,
Inspector (Passenger), National Board of Health

NEW ORLEANS, *September* 30, 1882.

Dr. S. E. CHAILLÉ,
Supervising Inspector, National Board of Health:

I hereby submit my report of passenger inspection on the Louisville and Nashville Railroad for the month ending September 30, 1882.

Number of passengers and certificates to Mississippi.

September 6 to 10, 1882	36
September 11 to 17, 1882	55
September 18 to 24, 1882	27
September 25 to 30, 1882	26
Total	144

Respectfully,

HENRY BEZOU, M. D.,
Inspector, National Board of Health.

NEW ORLAENS, LA., *September* 30, 1882.

Dr. S. E. CHAILLÉ,
Supervising Inspector, National Board of Health:

I hereby submit my report of passenger inspection on steamboats from September 6 to 30, inclusive:

Date.	Boats.	Passengers to Mississippi.	Certificates issued.
September 6 to 10	5	26	22
September 11 to 17	6	55	36
September 18 to 24	7	45	30
September 25 to 30	4	30	17
Total for four weeks	22	156	105

Respectfully,

S. R. OLLIPHANT, M. D.,
Inspector, National Board of Health.

APPENDIX M.

IMMIGRANT-INSPECTION REPORTS AND PAPERS.

1. REPORTS OF DR. JOHN H. RAUCH, JUNE–OCTOBER, 1882.
2. LETTER OF DR. J. FOURNESS BRICE, RED STAR LINE.
3. REPORTS OF DR. J. J. MULHERON, JUNE–OCTOBER.
4. LETTER OF DR. WILLIAM M. SMITH, HEALTH OFFICER PORT OF NEW YORK.

CHICAGO, ILL., *July* 3, 1882.

SIR: I have the honor to submit the following report of the operations of the immigrant-inspection service of the National Board of Health in the district under my charge, comprising the States of Indiana, Illinois, and Missouri, for the month ended June 30, 1882.

Inspections were begun June 1 on the Chicago, Pittsburgh and Fort Wayne Railroad by Assistant Inspector Starkweather, on the Michigan Central by Assistant Inspector Bundy, and on the Lake Shore and Michigan Southern by Assistant Inspector Kiernan. On the 5th of June Drs. Farrell and Newton were assigned to duty as assistant inspectors on the Grand Trunk and the Baltimore and Ohio roads, respectively. The foregoing are the main trunk lines entering Chicago. Assistant Inspector Conery, assigned to duty June 1, has charge of the Vandalia, the Ohio and Mississippi, the Wabash, and the Indianapolis and Saint Louis roads, crossing the Mississippi River at East Saint Louis; and Assistant Inspector Elder, assigned to duty June 20, inspects the trains arriving at Indianapolis over the Pittsburgh, Cincinnati and Saint Louis, and the Chicago, Columbus, Cincinnati, and Indianapolis roads.

The service being largely experimental, general instructions only were given the inspectors during the first week; but these, in addition to the instructions issued from your office, have been supplemented from time to time as experience pointed out needed modifications.

Much of the work in this district is necessarily dependent upon what is done at points farther east. It was discovered during the first week that but little reliance could be placed upon mere documentary evidence of protection. The steamship surgeon's protection card seemed to be issued in many instances with an entire disregard even of probabilities. It was found in the hands of persons who could exhibit no other proof either of being protected by a previous attack of small-pox or of ever having been vaccinated. It was traded around, exchanged, and used again by new-comers after having served its purpose with the original holder. Even during the past week a young unmarried woman presented a card for a mother and four children. On inquiry it was ascertained that she had obtained the certificate from a woman who had left the train before its arrival in this district.

It was also found that these cards and certificates were not only thus improperly issued and used, but in many instances were indorsed without examination by the inspector. In one instance a number of passengers by the steamer Illinois were found to have had certificates of domestic, social, and religious status, given by priests or pastors, countersigned as vaccination certificates by one of the Eastern inspectors. On June 6 a death from variola occurred at Rock Island, the victim being one of a party of seven German immigrants who arrived in that city all duly provided with the steamship protection cards. Of the seven, one has died, as above; three have had varioloid, and the remaining three have been successfully vaccinated. A similar case occurred at Elgin—the immigrant, also a German, contracting the disease during a brief stay in Chicago, notwithstanding his protection card.

These and kindred facts led me to issue specific instructions to the assistant inspectors, at the close of the first week, to vaccinate or revaccinate all persons coming under observation, so far as there was time and opportunity, *without regard to any evidence of protection not corroborated by personal examination.* These instructions have been reiterated from time to time, and the inspectors urged to the greatest possible vigilance and thoroughness, so that during the past week fully 25 per cent. of the total number of immigrants arriving in this district have been vaccinated or revaccinated by the assistant inspectors, while during the first week less than 5 per cent. were so treated.

In order to accomplish this result it has been found necessary to dispatch the inspectors to greater distances from Chicago to meet the incoming trains than was at first contemplated. On the Pittsburgh and Fort Wayne the inspector goes as far as Plymouth, Ind., 84 miles out; on the Lake Shore the trains are met at Elkhart, Ind., 101 miles out; on the Baltimore and Ohio they are met at Milford Junction, 106 miles from Chicago; on the Michigan Central, at Kalamazoo, 141 miles; and on the Grand Trunk, at Vicksburg, Mich., over 150 miles from the city. The above are the maximum distances. This service is quite arduous. Trains arrive irregularly; sometimes are run as specials, sometimes the immigrant cars are attached to regular trains, and sometimes the immigrants are carried in the regular passenger coaches.

Where immigrants are transferred from one line to another a new set of complications arises, rendering it difficult, sometimes impracticable, to secure information in season to meet the train at a sufficient distance from the city to make as thorough inspections as are desirable, and in some cases the regular hour of arrival in Chicago is so early as to leave little time. On the Pittsburgh and Fort Wayne, for example, Assistant Inspector Starkweather is obliged to go out every night and remain either at Valparaiso or Plymouth to meet the incoming train at 5 o'clock in the morning. This gives him only from two to four hours for inspection before reaching the city; but it is impossible to do better than this, since the work must be done in daylight. At East Saint Louis the inspector meets the early train on the Ohio and Mississippi at 5.30 a. m., and during the succeeding four hours has to look out for the trains over four roads, repeating this again between 5 and 9 p. m. Obviously, he is able to do little more than satisfy himself of the absence of any suspicious form of sickness, and to accept the exhibition of the protection card, but without in all cases satisfying himself as to the evidence upon which it is based. The inauguration of inspections at Indianapolis has to some extent remedied this defect, certificates of Inspector Elder's vaccinations being already noted at East Saint Louis. An additional inspector or assistant may, however, be necessary at this latter point in order to secure full protection to Saint Louis and points west.

As a rule every facility is afforded by the railway companies and agents; conductors and train-men render valuable assistance. In some instances the emigrant agent accompanies the inspector, and by his knowledge of the habits of the people, familiarity with their dialects, and his official position materially facilitates the work.

An increasingly large number of vaccinations on shipboard, as well as some by eastern inspectors, have been noted towards the close of the month. There is, however, a great disparity in the character of the work done on the steamers. On some the percentage of successful vaccinations is quite large, on others the reverse; and the contrast is so marked as to lead to the belief that the failures are due mainly to carelessness either in performing the operation or in the selection of the virus. Inspectors report that some of these failures, however, are due to the fact that the immigrants wash the virus off as soon as possible, and that it is necessary to watch them even on the trains lest they do so.

Thus far only two cases presenting sufficiently suspicious symptoms to warrant such action have been removed to hospital in this district, although a large number of cases of measles have been met with. In two or three instances these have been telegraphed from eastern points as cases of small-pox, but the mistake has always been detected in season to prevent any serious consequences.

Arrangements have been perfected with the local health authorities for the reception and care of cases in the established hospitals, the latest being with the authorities of the town of Lake, whereby patients arriving via the Lake Shore and the Pittsburgh and Fort Wayne roads will be transferred from the trains at Sixty-third street, some 8 miles from Chicago, instead of being brought up into the city, and then transported 3 or 4 miles thrcugh thickly crowded streets. Cases coming under the charge of the service at Indianapolis and at East Saint Louis, will, in like manner, be cared for in the hospitals of Indianapolis and Saint Louis respectively.

Although not yet perfect, the operation of the service has been of undoubted value even in these few weeks. In April there were 332 cases of small-pox in Chicago; in May, 281; while in June, notwithstanding the enormous immigration, there have been only 124 cases. The health commissioner, Dr. O. C. DeWolf, is disposed to attribute this large reduction in June in great part to the action of the service. It the State at large (Illinois), while for the previous eight months there was an average of ten importations by immigrants per month (there being nine during the month of May), there is only one which can possibly be attributed to this source during the month of June.

Appended is a tabular statement of the number of inspections and of vaccinations by each inspector during the period.

I am, sir, very respectfully,

JOHN H. RAUCH,
Supervising Inspector, National Board of Health.

Dr. THOS. J. TUNRER, U. S. N.
Secretary National Board of Health, Washington, D. C.

Locality.	Inspectors.	Railroads.	Persons inspected.	Persons vaccinated.
Chicago	R. E. Starkweather, M. D	Chicago, Pittsburgh and Fort Wayne.	5,683	592
	W. F. Bundy, M. D	Michigan Central	7,715	1,565
	J. J. Farrel, M. D.*	Grand Trunk	4,028	1,350
	J. G. Kiernan, M. D	Lake Shore	4,641	415
	F. C. Newton, M. D.*	Baltimore and Ohio	2,439	242
East Saint Louis	W. B. Conery, M. D.†	Vandalia, Ohio and Mississippi, Wabash, and Indianapolis and Saint Louis.	1,511	44
Indianapolis	E. S. Elder, M. D.‡	Pittsburgh, Cincinnati and Saint Louis, and Chicago, Columbus, Cincinnati and Indianapolis.	1,080	48
Totals			27,097	4,256

* From June 5 to June 30, inclusive.
† Inspections prior to June 8 not included in this number, being informal and general.
‡ From June 20.

SPRINGFIELD, ILL., *August* 4, 1882.

SIR: I have the honor to submit the following report for the month of July, of the operations of the immigrant-inspection service National Board of Health, in the district under my supervision.

During the month an aggregate of 20,000 immigrants were inspected by the assistant inspectors, who found about 16 per cent. of these unprotected—liable to contract small-pox and to propagate the disease. The necessary precautions were taken with all of these cases, as well as with one case of varioloid found in transit, and several convalescents, one being an immigrant removed from a train and treated in the small-pox hospital at Rochester during the month of June.

Although there is a marked improvement in the character of the protective work done on shipboard, as compared with that noted on beginning inspections, this is by no means uniform, as will be seen by the following extracts from the assistant inspectors' notes of careless, imperfect, or neglected vaccinations and revaccinations:

Steamship Republic.—"Practically worthless; no adult vaccinations."

Steamship Strasburg. *—"Very poor; only eleven successful out of 340 vaccinations; result evidently due to want of care on part of steamship surgeon."

Steamship General Herder.—"None showed successful vaccination."

Steamship Hermann. *—"Only thirteen properly protected out of 410; the vaccinations performed on shipboard very unsatisfactory. All passengers provided with *protection cards.*"

Steamship Rhynland.—"None showed successful vaccination on shipboard."

Steamship Mosel.—"No successful vaccination by the ship's surgeon."

Steamships Jason and Sardinia.—"No ship vaccination met with among passengers from either vessel."

Steamships St. Germain, Ethiopia, and Wieland.—"None vaccinated on shipboard; many totally unvaccinated children provided with ship's *protection cards.*"

Steamships Main and Surrey.—"Nearly all unsuccessful."

Steamships Brittanic and Italy.—"Vaccinations on shipboard generally poor."

Steamships Devonia and Warwick.—"Over one-half of the passengers by these two steamers were found to require vaccination, although all were furnished with ship's surgeon's cards which they had been told would prevent any other physician from interfering with them."

Steamship City of Brussels.—"Extremely little attention appears to have been given to the examination of its immigrant passengers while on board. One of these passengers, a Finn, twenty-eight years old, was found on a train nearing Chicago, July 24; was in the eruptive stage; eruption probably eighty hours old. He presented a vaccination-protection card, signed 'William Gibbons, surgeon steamship City of Brussels,' and dated July 20, 1882."

Steamship Illinois.—"A few only vaccinated."

Steamship Nebraska.—"Poorly revaccinated."

Steamship Indiana.—"Two-thirds required revaccination. No cards had been furnished any immigrants."

* These vessels, the Strasburg and Herman, are regular Baltimore packets, and the latter, at least, is known to have been the means of introducing small-pox into three several localities in Illinois during the past spring. It might be profitable to inquire to what extent such vessels and the neglect of their surgeons are responsible for the present prevalence of small-pox in Baltimore.

Concerning these cards it is noted that in many instances they bear no name of steamship or line. One such, presented by a lad thirteen years old and without the slightest evidence of vaccinal protection, bore the name of "John W. Watson, surgeon."

On July 28, among passengers by the steamer Erin, were found ten convalescent, who had had small-pox within a month before leaving Ireland.

Notwithstanding that the aggregate number of inspections was less in July than in the preceding month, the relative number is much larger. Immigration has probably fallen off one-half since May last, and it is believed that of the total number now arriving very few find their way into Illinois or cross the State without being subjected to one or more rigorous inspections. The reports of small-pox outbreaks in the region west of the Mississippi River have been notably less during July, while in this State there has not been a single case reported during the month outside of Chicago. The following table shows the steady decline of the disease in that city:

Month.	Cases reported.	Deaths.
April	321	92
May	281	65
June*	124	29
July	44	12

*Inspections began June 1.

At the close of the month there were only ten cases under treatment in the city, and one in the State at large.

In other districts of the service it is observed that increased familiarity with the work has secured increased efficiency, and thus materially lightened a labor which was found to be very onerous during the first month. For example, the vaccinations found to be necessary among passengers arriving over the Grand Trunk road in June were very nearly 36 per cent. of the total inspections. During July, owing to the increased number of vaccinations at Port Huron, Mich., this percentage has been reduced to 8.3 per cent.

Many cases of cholera infantum, measles, and whooping-cough are met with by the inspectors, who, so far as time and opportunity serve, render such medical assistance as is necessary.

The railway service has continued to afford every desired facility to the inspectors, and, aside from the advent of an occasional unannounced train over a connecting line, every emergency has been promptly met. The coaches for immigrant passengers are kept in good sanitary condition, and the general welfare of these people seems to be consulted on business principles.

I am, sir, very respectfully,

JOHN H. RAUCH, M. D.,
Supervising Inspector.

Dr. THOS. J. TURNER, U. S. N.,
Secretary National Board of Health, Washington, D. C.

Immigrant-inspection service, National Board of Health, Illinois district.—Inspections and vaccinations by the assistant inspectors, June 1–July 31.

Inspectors.	Stations.	June.		July.		June 1–July 31.	
		Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.
R. E. Starkweather, M.D...	Pittsburgh, Fort Wayne and Chicago Railroad.	5,895	592	3,452	398	9,347	990
Jas. G. Kiernan, M. D.....	Lake Shore and Michigan Southern Railroad.	4,641	415	1,828	547	6,469	962
W. F. Bundy, M. D.....	Michigan Central Railroad.	7,515	1,565	5,835	1,484	13,350	3,049
J. J. Farrell, M. D.*.....	Grand Trunk Railway...	4,028	1,450	2,551	212	6,579	1,662
F. C. Newton, M. D.*.....	Baltimore and Ohio Railroad.	2,439	242	1,448	318	3,887	560
E. S. Elder, M. D.†.....	Indianapolis	992	43	3,079	268	4,071	311
W. B. Conery, M. D.....	East Saint Louis.....	1,511	44	1,784	41	3,295	85
Totals	....	27,021	4,351	19,977	3,068	46,998	7,619

*Inspections began June 5. †Inspections began June 20.

IMMIGRANT-INSPECTION SERVICE, NATIONAL BOARD OF HEALTH.

OPERATIONS IN THE WESTERN DISTRICT DURING THE MONTH OF AUGUST.

SPRINGFIELD, ILL., *September* 6, 1882.

SIR: The following report of the operations, during the month of August, 1882, of the immigrant-inspection service, National Board of Health, in the district under my supervision, is respectfully submitted.

An aggregate of 16,014 inspections were made by the seven assistant inspectors, who performed 3,125 vaccinations upon immigrants found to be either imperfectly or not at all protected by previous vaccination or attack of small-pox. This is in the ratio of about 20 per cent. of vaccinations as against 16 per cent. during the months of June and July.

It is not to be inferred from this, however, that the proportion of unprotected immigrants is larger than in the previous months. On the contrary, increasing evidence has been found throughout the month of greater care and vigilance on the part of steamship surgeons generally, and of some of the inspectors east of this district—notably at Port Huron, Michigan—and a much larger proportion of recent vaccinations has been met with as the result of this care and vigilance.

An analysis of the inspectors' reports shows the highest ratio (nearly 38 per cent.) of vaccinations to inspections to have been made among immigrants arriving via Baltimore. And this is due to the cause indicated in my last report, namely, the neglect of surgeons of steamers arriving at that port to enforce vaccination, although there has been a very decided improvement in this respect during the past month, as will be seen in the comments of inspectors quoted below.

Aside from this cause—which is exceptional—the increased facility with which inspections are now made, as the result of experience and familiarity with the work, and the smaller number of arrivals during the month, whereby inspectors have been enabled to devote more time to each individual (always vaccinating the doubtful cases), sufficiently account for the increased proportion of vaccinations.

The smallest ratio of vaccinations to inspections—in other words, the smallest number of unprotected immigrants out of a given number arriving in this district—is that among passengers by the Grand Trunk Railway. Only 3½ per cent. of these were found to need vaccination by the Illinois inspector, that work having been thoroughly performed by the inspectors at Port Huron. The ratio on this road has steadily declined from 36 per cent. in June to 8.3 per cent. in July and 3.5 per cent. in August. During the latter part of the month *all* of the arrivals by this road were found to be protected.

Of the arrivals in this district during the past three months, my observations go to show that 54 out of every 100 immigrants were protected against small-pox before landing in this country, in one of the three following methods:

Three out of every 100 by a previous attack of small-pox.

Forty-three out of every 100 by a mature successful vaccination.

Eight out of every 100 by a recent successful vaccination or revaccination performed on shipboard.

Taking the whole season throughout, only 22 out of every 100 steerage passengers have been vaccinated on shipboard; but this number is nearly doubled for the latter part of August, when it rose to 41 in every 100. Of the vaccinations by the steamship surgeons, 36.7 per cent. are now successful, but there are still nearly two-thirds failures in the aggregate.

Less than 4 per cent. of the arrivals in Chicago are found to have been vaccinated at all eastern points, exclusive of Port Huron; at this latter station nearly 36 per cent. of those destined for Illinois and westward are vaccinated.

In the western district, thus far, a little over 96 per cent. of the unprotected arrivals have been vaccinated by the inspectors within the district before entering or crossing the State, the 3 or 4 per cent. escaping vaccination being composed of cases where contra-indicating conditions existed, or where the operation was refused.

The necessity for this mode of excluding imported small-pox contagion has received signal confirmation during the month by two local outbreaks of the disease in Illinois, which show that notwithstanding all the efforts made to secure the proper vaccinal protection of the State there are still locations where the introduction of the infection is sufficient to discover unprotected individuals enough to cause considerable alarm.

In Jersey County eight cases and one death, up to date of last report, had resulted from a suit of second-hand clothes bought in Saint Louis by a railroad hand and brought to Elsah, where the first cases appeared in a family to which the clothes were taken to be washed. From Elsah it was carried to Jerseyville, where three cases have resulted among hands employed by the Wabash Railroad Company.

Ten cases have occurred near Harrisonville, Monroe County, the source of contagion

being infected bedding, clothing, etc., thrown into the Mississippi River and lodging upon an island where the outbreak occurred.

With the above exceptions there has been only one case of varioloid in the State (outside of Chicago) since June 23. The case referred to is that of a farmer returning to Paxton, Ford County, from France, with a cargo of imported horses. He was carried on a Danish stock boat, the Friga, and contracted the disease from a stockman on board who was suffering with a mild case of varioloid. The attending physician writes that "there was no examination at New York," and as the man did not travel as an immigrant, he, of course, escaped inspection by the service.

In Chicago there have been only twenty-four cases and five deaths during the month, and at the close of the month there were only three cases under treatment in hospital and two in the city.

To the table presented last month are now added the figures for August, showing the continued decline in that city since beginning inspection:

Month.	Cases reported.	Deaths.
April	321	92
May	281	65
June	124	29
July	44	12
August	24	5

Inspection began June 1. Average decline before inspection, 12 per cent. Average decline since inspection, 78 per cent.

This result plainly demonstrates that no matter how efficient a health department may be within its own limits, nor how general and thorough vaccination may be made in a given community, large cities like Chicago must be protected from without against laches and defects in the administration of seaboard quarantines in order to escape the effects of continuous importations of foreign contagion.

During the month I have made some observations upon the operations of the service in adjoining territory. Going to Montreal along the line of the Grand Trunk Tailway, I visited Lansing and Port Huron, in Michigan, and at the latter station spent some time with Inspector Mills and his assistants. Their work seems to be very thorough and efficient. During the last twenty-six days of August the probabilities are that not a single unprotected immigrant has been allowed to pass this station.

The absence of the Canadian health officials prevented any extended study of the work in the Dominion, and I was disappointed in not being able to await the arrival of a steamer at Quebec, having intended to observe the operation of the quarantine service at the port of arrival, and then to accompany the newly-arrived immigrants from their debarkation to the western district. Returning from Montreal to Port Huron, I proceeded to Detroit and spent sufficient time with Inspector Mulheron to satisfy myself concerning the character of the work there. A larger number of vaccinations are now being performed at the Detroit station than hitherto.

Leaving Detroit on an immigrant train, over the Michigan Central, abundant opportunity was afforded to note all the conditions of this form of travel. Among other results of the inspection service it was evident that there was a very marked change in the conduct of the immigrants themselves; that they were more cleanly in their habits, and took better care of themselves and families. Not a single sick child was found among these 351 passengers—a most noteworthy instance, and one without parallel in my previous experience. The railway officials confirmed my own observations by their statements. These evince a lively interest in the service, recognizing its contingent personal benefits, and always affording a ready assistance to the inspector in the discharge of his duties.

The same condition which I have had occasion elsewhere to condemn with reference to long trip through trains, obtains in an aggravated degree upon these immigrant trains. Inspector Starkweather makes the following comments upon the matter in his summary for the month:

"Repeated observations in regard to the sanitary condition of the cars occupied by the immigrants has greatly impressed me with the very decided differences to be met with between those coaches that were sent from New York to this city and those coaches that were sent only from Pittsburgh or Mansfield; in other words, between the condition of the cars in the through or so-called solid trains and those made up half way between the points named, as at Pittsburgh or Mansfield. As a rule, immigrants from New York City or Philadelphia by Pennsylvania Railroad and Pittsburgh, Fort Wayne and Chicago Railway are obliged to change cars at Pittsburgh. Those traveling via

New York, Pennsylvania and Ohio Railroad and the New York, Lake Erie and Western Railroad, its connecting link, were very often conveyed the whole distance to this city in the same car.

"I have seldom found a car to be free from foul air, or to be clean either in respect to its aisles and floors, its seats or closets, which has carried its full complement of immigrants (averaging about forty people to the car) from New York City to Chicago without change.

"It would also be a good sanitary measure if the tank holding the drinking water were to be located outside of the water-closet compartment instead of occupying the location now generally assigned to it, even in the best of passenger coaches."

It will be noted in the following extracts from the assistant inspectors' reports that occasion has been found to speak approvingly of a much larger share of the steamship work than ever before:

Steamship Rhein of the North German Lloyd's.—"The surgeon has made a most excellent inspection of his people, and performed a large number of very effective adult revaccinations."

Steamship Waesland.—"The inspections by Surgeon Burroughs have been exceedingly thorough. His adult revaccinations numerous and effective."

Steamship Malta.—"The surgeon has been very particular in vaccinating. Those requiring vaccination who have arrived by this vessel are very few."

Steamship Ohio.—"These passengers had been very thoroughly inspected, and the surgeon had performed a number of very fine adult revaccinations."

Steamship Elbe.—"Her surgeon had made a very rigid and excellent inspection, and had done a large number of good adult revaccinations."

Steamship British Crown.—"The work of Dr. Bullock of the British Crown merits very high commendation for its thoroughness and efficiency."

Steamship Celtic.—"Some very excellent adult revaccinations."

Steamship Hohenstaufan.—"Surgeon's inspection very rigid. A very large number of vaccinations had been performed on or about July 24, but, judging from the result, the material used appears to have been very inert."

Steamship City of Richmond.—"The vaccinations on board this vessel have been very effective."

Steamship Herder.—"The surgeon had vaccinated nearly every one of his adult immigrants; the method employed, however, is not well calculated to produce a typical scar."

Steamship Hermann.—"Inspections on this trip seem to have been thorough, and vaccination or revaccination general and tolerably successful."

On the other hand—

Steamship Neckar.—"Attention is called to the marked difference in the results of the vaccinations on the two steamers Neckar and Rhein. On each steamer nearly every passenger was vaccinated. On the Neckar, result, total failure; on the Rhein remarkably good results were obtained."

Steamship Hekla.—"All the immigrant passengers had been vaccinated on the vessel, and none were successful."

Steamship Polynesia.—"Of 54 vaccinations performed on board only 2 were successful. It was found necessary to vaccinate 74 out of 164 of her passengers found on this train."

Steamship Indiana.—"No cards had been issued to the passengers on this vessel, and few, if any, vaccinations had been performed. The vessels of this line do not, so far as can be ascertained, pay any attention to the inspection of their passengers, nor do they seem to be required to do so at that port (Philadelphia). I have never seen any indications that there is a medical inspector of immigrants on duty there."

Steamship State of Georgia.—"Many adults requiring vaccination had been allowed to pass inspection."

Steamship Parthia.—"The ship vaccinations were either total failures or resulted in very doubtful vesicles."

Steamship Leipsig.—"Of 394 passengers by this vessel 181 were found more or less unprotected and requiring vaccination. Not one among the number showed a recent successful vaccination, and only a few bore any evidence of having been inspected on shipboard, although all were furnished with protection cards."

"Very little attention is paid to adult vaccination" by the surgeons of the Allemand, Amerique, Vaterland, Bothnia, and Switzerland.

"No inspections of any value" appear to have been made by the surgeons of the Pollux, Plantyn, or Leipsig.

Inspections by the surgeons of the steamers Alaska, City of Rome, Cimbria, Edam, Egyptian Monarch, St. Laurent, Nemesis, Parthia, and Britannic "appear to have been very superficial."

Protection cards were found in the possession of unvaccinated individuals from the steamers Wyoming, Salier, and Frisia.

The protection cards issued by the steamers Helvetia, Frisia, Parthia, and Westphalia bore no name of steamer or of line, and valuable time is lost in identifying such cards by other evidence.

Inspector Bundy (Michigan Central) says of his inspection, August 13:

"Such as are vaccinated at Port Huron or Detroit have the ship's card taken away and the inspector's card given instead. This makes it tedious and in many cases impossible to ascertain the names of the vessels on which they sailed.

"One child, five months of age, was not vaccinated, the surgeon of the Donau saying it was not necessary, but giving it a card.

"From steamer Thingvalla 204 passengers; no successful ship vaccination, but 91 vaccinated at Port Huron. In these eight coaches I found 12 ship vaccinations working and 147 Port Huron vaccinations.

"The three car-loads at rear of train had been thoroughly revaccinated at Port Huron. This train showed evidence of more thorough inspection since leaving the seaboard than any train previously seen."

On a train over the Michigan Southern and Lake Shore on August 13 five Bohemians were found recently recovered from variola, which had been very prevalent in their village three weeks before they left. The inspector reporting this adds that "the practice of taking passengers from way stations and allowing them to ride in the immigrant cars is certainly objectionable. These passengers resist inspection and encourage the immigrant to do the same. There is, of course, a possibility that in this way contagion may reach various districts."

The appended table shows the number of inspections and vaccinations by each inspector for the month and for the total period, June 1 to August 31.

I am, sir, very respectfully,

JOHN H. RAUCH, M. D.,
Supervising Inspector.

CHARLES SMART, *Surgeon United States Army,*
Secretary National Board of Health, Washington, D. C.

IMMIGRANT-INSPECTION SERVICE, NATIONAL BOARD OF HEALTH, WESTERN DISTRICT.

Inspections and vaccinations by the assistant inspectors, June 1—August 31, 1882.

Inspectors.	Stations.	June and July.		August.		June 1—Aug. 31.	
		Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.
R. E. Starkweather, M. D.	Pittsburgh, Fort Wayne and Chicago Railroad.	9,347	990	2,918	541	12,265	1,531
James G. Kiernan. M. D..	Lake Shore and Michigan Southern Railroad.	6,469	962	2,754	662	9,223	1,624
W. F. Bundy, M. D	Michigan Central Railroad.	13,350	3,049	2,942	950	16,292	3,999
J. J. Farrell, M. D.*	Grand Trunk Railway.....	6,579	1,662	709	25	7,288	1,687
F. C. Newton, M. D.*	Baltimore and Ohio Railroad.	4,837	740	1,609	603	6,446	1,343
E. S. Elder, M. D.†.....	Indianapolis.....	4,071	311	3,313	248	7,384	559
W. B. Conery, M. D	East Saint Louis.....	3,295	85	1,769	96	5,064	181
Totals.....	....	47,948	7,799	16,014	3,125	63,962	10,924

*Began inspecting June 5.

†Began inspecting June 20.

IMMIGRANT-INSPECTION SERVICE, NATIONAL BOARD OF HEALTH.

OPERATIONS IN THE WESTERN DISTRICT DURING THE MONTH OF SEPTEMBER, 1882.

OFFICE OF THE SUPERVISING INSPECTOR,
Springfield, Ill., October 10, 1882.

SIR: During the past month there have arrived and been inspected in this district, comprising the States of Indiana, Illinois, and Missouri, a total of 14,404 immigrants, of which number 2,918, or about one-fifth, were found imperfectly or not at all protected against small-pox, liable to contract the disease and to propagate the contagion. Of these, 234 had never before been vaccinated, among whom were many adults.

There were found *in transitu* five cases of small-pox, which were removed to hospital in Saint Louis and Chicago, respectively, the necessary precautions taken with those who had been exposed, and the cars and belongings thoroughly cleansed and disinfected. Of these cases the inspectors have made full and detailed reports, that of Inspector Starkweather being as follows:

September 6.—Found a case of modified small-pox in the person of a single woman, thirty-nine years of age, coming from a small town near Manchester, England, and bound for Neenah, Wisconsin. She had been vaccinated only once, and then in infancy. She presented a card of which the following is a copy: (No date to the card.)

> CUNARD LINE.
>
> **VACCINATED.**
>
> *S. S. SCYTHIA.*
>
> (Signed)
>
> W. J. KING, *Surgeon.*

On the obverse was the following, printed in English and four other languages: "*Keep this card to avoid detention at quarantine and on railroads in the United States.*"

The patient occupied passenger car No. 424 of Pennsylvania Railroad. The rash appeared on Monday morning, September 4, at or before the time of leaving the ship. The ship's surgeon did not look at her arms, she said, nor, so far as I could ascertain, did he do any vaccinating of his people, and made only a very superficial and worthless inspection. The eruption must have appeared sixty hours before the time I first saw her. It was located upon the forehead, cheeks, neck, and upper extremities somewhat abundantly; none apparent upon lower limbs. The patient said it was prickly heat, and that she would soon be over it if allowed to go on to Neenah.

Oscar C. De Wolf, M. D., health commissioner of this city, saw the patient with me in consultation on the car at my request, partly to satisfy the patient and partly to protect the Inspection Service and railroad corporation against possible malicious action for damages in the future. She made no opposition to being taken in the ambulance to the small-pox hospital. The car was thoroughly fumigated by the city health department, and the necessary instructions were given to the railway company concerning its present use.

I vaccinated sixty-five adults, who had been more or less exposed on the train, the railroad officials cheerfully and courteously rendering every needful assistance. Two of the people whom I vaccinated at their own request belonged to the crew of the train.

This case was detected before leaving Valparaiso, Ind., but, partly owing to want of facilities at any point nearer than Chicago, it was brought on to that city for treatment, every precaution being meanwhile taken to prevent any exposure of others during the remainder of the journey.

The cases, four in number, removed to the hospital in Saint Louis were detected while still in Illinois. These were found among a party of Bohemians bound for Missouri; have all since convalesced and been discharged. So far as has been ascertained, no other cases have been caused by these.

The importation into Ford County, Illinois, reported in my last, gave rise to three other cases, of which one terminated fatally. (This was the importation by a horse-dealer returning from France on a stock-boat, the Friga, which boat, it is alleged, escaped inspection at New York quarantine. The horse-dealer Hefner contracted his disease from a case of modified small-pox which occurred during the voyage. As he did not travel as an immigrant in this country, he was not seen by any of our inspectors.) The outbreak was confined to one family, and danger of any further spread is not now anticipated.

Concerning the character of the protective work done by steamship surgeons, there is still the same disparity noted as has been commented upon before. Passengers arriving

by vessels of the same line present the most marked contrasts. On one the surgeon will have made a careful inspection and have vaccinated or revaccinated all unprotected or doubtful cases; on the very next arrival by the same line evidences of gross carelessness will be found in children of all ages holding the surgeon's cards, but without any personal evidence of ever having been vaccinated; and in the case of adults not revaccinated since infancy, but similarly equipped with cards to secure them, in several languages, "against detention on railroads in the United States."

Copies of my previous reports, forwarded to the officers of the various lines, have in many cases, it is believed, been productive of improvement in this respect; but the steamship medical service is not yet by any means what it should be in its treatment of immigrant passengers with regard to the preservation of health. In the absence of any adequate national legislation prohibiting the introduction of foreign pestilence, and the want of proper State and local legislation, I know of no better method of securing the result, under present conditions, than by giving publicity to the character of the work done by each surgeon, as shown in the condition of the immigrants passing through his hands and arriving in the interior.

Unprotected immigrants, susceptible to small-pox and capable of propagating the contagion, have been received in this district during the past month from the following vessels:

Steamship Abyssinia, Guion line, Surgeon Satterthwaite.
Steamship Arizona, Guion line, Surgeon Luttrell.
Steamship Australia, Hamburg-American line, Surgeon Carr.
Steamship Bermuda, line and surgeon not reported.
Steamship Britannic, White Star line, Surgeon O'Laughlin.
Steamship British Crown, American line, Surgeon Bullock.
Steamship Canada, Transatlantic Company, Surgeon Guichard.
Steamship Circassia, Anchor line, Surgeon Faulds.
Steamship Circassian, Anchor line, surgeon's name not learned.
Steamship City of Chester, Inman line, Surgeon Irwin.
Steamship City of Montreal, Inman line, Surgeon Parker.
Steamship Dupuy de Lome, Compagnie-Commerciale des Transports à Vapeur Français, Surgeon Ruby.
Steamship Edam, Royal Netherlands line, Surgeon Crums.
Steamship England, National line, Surgeon Collins.
Steamship State of Georgia, State Steamship Company, Surgeon Hamilton.
Steamship Germanic, White Star line, surgeon's name not given.
Steamship Leipzig, Hamburg-American line, Surgeon Schlaeger.
Steamship Lord Clive, American line, surgeon's name not given.
Steamship Main, North German Lloyds, Surgeon Koethe.
Steamship Malta, Cunard line, surgeon's name not given.
Steamship State of Nebraska, State Steamship Company, surgeon's name not given.
Steamship Ohio, American line, surgeon's name not given.
Steamship Ontario, Dominion line, surgeon's name not given.
Steamship Parthia, Cunard line, Surgeon Donovan.
Steamship Pavonia, Cunard line, Surgeon Tanner.
Steamship Pennsylvania, American line, Surgeon Raynor.
Steamship Plantyn, White Cross line, Surgeon Spainlin.
Steamship Pollux, Royal Netherlands line, Surgeon Garbrett.
Steamship The Queen, National line, Surgeon Freeland.
Steamship Strasburg, North German Lloyds, surgeon unknown.
Steamship Westphalia, Hamburg-American line, Surgeon Tenser.
Steamship Wyoming, Guion line, Surgeon Quin.

The most notable line for disregard of vaccinal protection of its passengers is the American, of Philadelphia. In one instance twelve passengers out of fifty by the steamer Pennsylvania, of this line, were found totally unprotected, never having been vaccinated at all. Yet every one had been furnished a steamship protection card. This proportion will hardly hold good throughout, but the number of unprotected by this line is far in excess of any other.

In gratifying contrast to the foregoing exhibit is that made by the surgeons of the following named vessels, many of them belonging to the lines above enumerated, but on which the vaccinal service appears to be thorough, the inspections careful, and the vaccinations and revaccinations effective:

Allan line.—Steamship Sardinia, name of surgeon illegible on cards presented.

Anchor line.—Steamship Ethiopia, Surgeon Grade.

Cunard line.—Steamships Samaria, name of surgeon not given; Servia, Surgeon Brady; Cephalonia, surgeon's name not given.

Dominion line.—Steamship Dominion, name of surgeon not given.

Great Western line.—Steamship Gloucester, Surgeon Addensell.

Guion line.—Steamship Iowa, name of surgeon not given.

Hamburg-American line.—Steamships Bohemia, Surgeon Kurtz; General Werder, Surgeon Raulenberg; Wieland, Surgeon Hempricht; Frisia, Surgeon Wiesberger; Vandalia, Surgeon Schwindle; Gellert, name of surgeon illegible.

Inman line.—Steamships City of Chester, Surgeon Irwin; City of Berlin, Surgeon Reynolds; City of Paris, surgeon's name not given.

Monarch line.—Steamship Grecian Monarch, Surgeon Kirby.

National line.—Steamships Helvetia, Surgeon Russell; Spain, surgeon's name not given; Egypt, Surgeon Morrison.

Netherlands-American line.—Steamships Schiedam, Surgeon De Vogel.

North German Lloyds.—Steamships Salier, Surgeon Bamberger; Nurnberg, Surgeon Yungberger; Elbe, Surgeon Scharff.

Red Star line.—Steamships Vaterland, Surgeon Nauroch; Pennland, Surgeon Moore; Belgenland, Surgeon Sterling Erskine; Switzerland, Surgeon Burke; Waesland, Surgeon Burroughs.

Royal Netherlands line.—Steamships Surrey, Surgeon Gies; Jason, Surgeon Farlemam.

State Steamship Company.—Steamships State of Florida; surgeon's name not given; State of Missouri, surgeon's name not given; State of Indiana, Surgeon Dougall.

Stettiner-Lloyd's.—Steamship C. H. Schultz, Surgeon Miller.

Thingvalla Company.—Steamships Hekla, Surgeon Siwalt; Island, Surgeon Laker.

Transatlantic Steamship Company.—Steamships France, Surgeon Bouchet; Amerique, Surgeon Le Roy; St. Laurent, Surgeon Perin.

White Star line.—Steamship Baltic, Surgeon Browne.

One inspector notes the difference in passengers arriving by vessels of the same line at Boston and at New York, and attributes the superiority of those arriving at the former port to the character of its inspection service. I have also had occasion to note that we have had in Illinois but one case (a mild varioloid) which could be attributed to Boston in something over a year.

Evidence of the growing interest in this protective measure is found in the increasing numbers of immigrants vaccinated or revaccinnated just before sailing. This is especially true of the English and Scotch, and in a great measure offsets the occasional opposition to the inspection met with from individuals of the same nationalities, and which seems to be due to the anti-vaccinationists of Great Britain.

Vaccination performed at this time, *i. e.*, prior to sailing, has the advantage of enabling the steamship surgeon to judge of its effectiveness during the voyage; and it would be a decided improvement on the present general plan of waiting until the last days of the voyage if the surgeon would perform the operation as soon after leaving port as practicable. This would give him an opportunity of noting the value of the virus and result of his work, besides facilitating the labor of inspection upon and after arrival. I think that a circular letter from the Board making this request of the managers of the various steamship lines would meet with a favorable reception.

The disparity in the results of vacination performed on shipboard is due, possibly, as much to the method of performing the operation as to the character of the virus employed, though there is, doubtless, much of this used which has become inert, either from being kept too long or from exposure to the salt moist atmosphere. Both of these evils would be most likely to be remedied if the surgeon was able to follow up the results of his work.

As all doubtful cases in this district, that is, those in which the evidence of proper vaccinal protection is not clear and unmistakable, are carefully vaccinated with virus seldom more than seventy-two hours from the heifer, it is probable that those passing through our hands are more thoroughly protected than many of our citizens.

Recent action in England, detailed in the following, will tend to still further lighten the responsibility of this service:

Dr. Bloxall, Royal Navy, one of the medical inspectors of the local government board, accompanied by Captain Wilson, representing the Board of Trade, has opened at Liverpool an inquiry with regard to certain sanitary questions connected with emigration, and as to the circumstances in which emigrants passing through the port of Liverpool are placed before sailing. He is likewise instructed to inquire as to the provision made for the isolation and treatment of sick persons arriving from infected places on the Continent or in the United Kingdom; and, further, as to the sanitary arrangements and supervision of the lodging-houses into which emigrants are received, and the means taken with respect to infectious diseases occurring therein.

In a few instances the cars have been found wet and dirty, especially those transferred from connecting lines; but as a rule their sanitary condition is quite satisfactory.

Cholera infantum among children and diarrhœa among adults were quite frequently met with in the early part of the month. One child died *en route* of the former disease.

Measles and chicken-pox have appeared often enough to keep the inspectors on the alert and to demand the exercise of discretion and prudence in dealing with their subjects.

Appended is a table showing the number of vaccinations and revaccinations by each inspector for the month and for the total period, June 1 to September 30.

I am, sir, very respectfully,

JOHN H. RAUCH, M. D.,
Supervising Inspector.

CHARLES SMART,
Major and Surgeon, U. S. A., Secretary National Board of Health.

IMMIGRANT-INSPECTION SERVICE, NATIONAL BOARD OF HEALTH, WESTERN DISTRICT.

Inspections and vaccinations by the assistant inspectors, June 1 to August 31, 1882.

Stations.	June—August.		September.		June 1 to September 30.	
	Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.
Pittsburgh, Fort Wayne, and Chicago Railroad	12,265	1,531	2,560	618	14,825	2,149
Lake Shore and Michigan Southern Railroad	9,223	1,624	2,179	396	11,402	2,020
Michigan Central Railroad	16,292	3,999	2,839	1,006	19,131	5,005
Grand Trunk Railroad*	7,288	1,687	949	64	8,237	1,751
Baltimore and Ohio Railroad*	6,446	1,343	1,747	402	8,193	1,745
Indianapolis†	7,384	559	3,029	294	10,413	853
Saint Louis	5,064	181	1,101	138	6,165	319
Totals	63,962	10,924	14,404	2,918	78,366	13,842

* Inspection began June 5.

† Inspection began June 20.

IMMIGRANT-INSPECTION SERVICE, NATIONAL BOARD OF HEALTH.

OPERATIONS IN THE WESTERN DISTRICT DURING OCTOBER.

OFFICE OF THE SUPERVISING INSPECTOR,
Springfield, Ill., November 10, 1882.

SIR: I have the honor to submit the following report of the operations of the National Board of Health Immigrant-Inspection Service in the district under my charge for the month of October:

Of the immigrants arriving in the district during the month, 16,473 were inspected by the assistant inspectors, who found 3,353, or about one-fifth of the whole number, whom they deemed it desirable to vaccinate or revaccinate. Among these were 350 who had never been vaccinated at all, and these included an unusually large number of adults.

It may be observed in passing that only those are included among "imperfectly protected or unprotected"—*i. e.*, susceptible to small-pox—in whom the weight of evidence is strongly against the presumption of satisfactory protection. Where there is found reasonable ground for belief that the individual is protected by reason of insusceptibility—as shown, for example, in an unsuccessful attempt at vaccination by a ship's surgeon of approved record, or by an Eastern inspector after landing—such a case is included among the "protected." There is, undoubtedby, a certain percentage of error in such judgments, but it is not believed to be large enough to have any practical significance, and the number vaccinated or revaccinated after arrival in the district may be taken as the approximately correct figures of the susceptible.

Of the total number (16,473) of immigrants inspected in this district during the month, 4,728, or nearly 30 per cent., were susceptible on landing; but 1,364 of these were vaccinated or revaccinated by Eastern inspectors before arriving in the Western district. If this proportion holds good with the total number of immigrants arriving in the country, then only a little over one-third of the susceptible are properly protected in the Eastern inspection districts. This may be due to the reduction in the number of inspectors last

month, but it is also probable that the inspectors pay more attention to the immigrants who settle down in their respective districts, and only vaccinate as many of those going beyond their boundaries as they find time and opportunity for.

No unprotected immigrant should be landed. Where a port refuses to adopt such a regulation it is probable that sufficient pressure may be brought to bear upon the steamers, through the railroad companies, to secure the desired end. To do this it would require that State and local boards of health should charge the railroad companies with the expense of vaccination, as well as of the care of the infected brought by them, and of disinfection, etc. If it were understood that such expense, as well as the delay, interference with the movements of trains, and other annoyances, could be obviated by securing from the steamers compliance with so obviously reasonable a requirement, it cannot be doubted but that the railroad companies have sufficient influence to obtain such compliance. This roundabout method of dealing with the steamship companies would, of course, be unnecessary were maritime quarantines based on approved sanitary principles and administered in the interests of the whole country, rather than that of a port or section. In too many instances immigrants are hurried through such ports with only so much of an inspection as apparently serves to protect the port itself from the actual presence of contagious disease.

There would be nothing onerous in the requirement above suggested, for if the steamship companies would unite in refusing to carry unprotected immigrants, intending passengers would secure protection before applying for passage. Failing to do this, the ship's surgeon has usually time and opportunity enough during each voyage in which to examine every passenger and to properly vaccinate those requiring it.*

As the matter now stands, at the end of the fifth month of this service there are manifest inequalities in the work, both as to kind and quantity, alike of the steamship surgeons afloat and the inspectors of the service on shore. Some of the former do not even go through the form of inspecting their passengers, others merely inspect and furnish cards, but without vaccinating; still others vaccinate only unvaccinated children, and pay no regard to adults, no matter how remote the date of their original vaccination. Some of the steamship companies which furnish cards to their passengers omit the name of the company, of the steamer, and of the surgeon; in short, furnish no clew to their identity.

It has become very obvious to me that some other measures must be resorted to than those hitherto relied upon to exact honest and effective work from many of the steamship surgeons. In the administration of the service in this district I have studiously endeavored to throw no obstacle in the way of travel. Inspectors have subordinated their hours for sleep and meals to the movements of the various roads, and every effort has been made to discharge the duty with the least possible annoyance or interference.

Many of the evils and difficulties experienced can only be overcome by enforcing the inspections and the necessary precautions without regard to delays and detentions. This will necessarily be unpalatable to the railroads, but they can obviate it all by insisting that the steamship companies do their duty in the premises.

Analysis of an inspector's work in the western district for the month of October, 1882:

Total number of immigrants inspected			3,199
Total number found protected—			
By previous effective vaccination or revaccination	1,694		
By previous attack of small-pox	36		
By effective ship vaccination	294		
By Eastern inspectors' vaccination	125		
		2,059	
Total vaccinated or revaccinated by Western inspectors		1,140	
			3,199
Total number found to have been vaccinated or revaccinated on shipboard			710
Result of ship vaccination—			
Successful	189		
Modified	105		
Failure	416		
			710

*The former surgeon of an immigrant steamer informs me that it is the usual custom of steamship surgeons to get a large supply of vaccine virus at one time, and use of it till gone, however long. He says they often use virus several months old. Old and inert lymph is furnished by the wholesale druggist at reduced figures. The inspection on shipboard is done hurriedly, and seldom is any pains taken to see all. Not unfrequently the protection cards are given on the word of the immigrant himself, without the doctor taking the trouble to see either the arm or the certificate of vaccination.

Total number vaccinated in Eastern districts		125
By New York inspectors	8	
By Detroit inspectors	29	
By Port Huron inspectors	88	
		125
Total number vaccinated in Western district		1,140
Total number revaccinations	1,097	
Total number primary vaccinations	43	
		1,140

There have been seven cases of small-pox removed from trains during the month. Of these, five were found on a car of the New York, Pennsylvania and Ohio Railroad, in a Pittsburgh, Fort Wayne and Chicago train. Three of them were passengers via steamer Herder, of the Hamburg-American line. These were destined for Grundy County, Illinois, near Braidwood. The other two of these five were landed from the Netherland-American steamer Leerdam, Surgeon Wright, and were bound for Davenport, Iowa. None of these had been revaccinated.

The remaining two were passengers by the steamer Pavonia of the Cunard line, Surgeon Manner, and the steamship Egypt, of the National line, Surgeon Morrison. These were both adults, and had never been revaccinated. The Pavonia passenger, who was found on a Pennsylvania Railroad car, nearing Chicago, stated that the surgeon vaccinated none "who had a visible mark," but that he looked at all the arms. The passenger by the Egypt had been vaccinated when eight years old, but not since—a period of twenty years. This case proved to be hemorrhagic and confluent, and terminated fatally.

The first six cases were removed to the Chicago small-pox hospital, and the remaining one, which was discovered at East Saint Louis, on the Indianapolis and Saint Louis Railroad, was taken to the Saint Louis quarantine hospital. The infected cars were sidetracked and thoroughly cleansed and disinfected, and all exposed individuals were at once vaccinated.

The following table, compiled from the weekly reports of the inspectors, shows—

In the first column of figures, the total number of immigrants inspected in the Western district, claiming to have arrived by given steamers.

In the second column, the numbers of such who were found to be perfectly protected by (1) recent successful vaccination or revaccination, either before sailing or on shipboard, or (2) by a previous attack of small-pox.

In the third column, the number of such who were adjudged by the inspectors to have been imperfectly protected on landing, either because the vaccinal scar was defective, or because it was not sufficiently recent, or—in cases of recent vaccination, either on shipboard or after landing—because of failure, probably due to inert virus, or to faulty method of operating, or to interference with the operation by the subject.

And in the last column, the numbers of such who had never been vaccinated or otherwise protected against small-pox.

It will be noted, in comparing the totals of this table with the totals of the summary appended to the report, that there are some apparent discrepancies. For example, the total number inspected, as given in the summary, is 16,473; in this table it is 15,999—the difference, 475, being made up of arrivals by irregular or unknown steamers. On the other hand, this table includes 4,728 imperfectly protected or unprotected immigrants, who should presumbly have been vaccinated in the Western district; whereas the total number of vaccinations and revaccinations reported by the Western inspectors is only 3,353; but this difference, 1,375, is made up of those vaccinated by Eastern inspectors, and of the very few—less than a dozen in all—whom it was deemed inadvisable to submit to the operation.

Study of the table is instructive in revealing the wide range in the character of the work done by the steamship surgeons. Taking those vessels the figures of which are large enough to generalize from, it is found that the proportion of unprotected or imperfectly protected immigrants landed in this country from given steamers varies from less than 5 per cent., as in the case of the America, of the North German Lloyd line, to over 54 per cent., as in the case of the Island, of the Thingvalla line. As between vessels of the same line, there is also seen the same disparity heretofore commented on—*ex. gr.*, the America, above cited, and the Donau, both of the North German Lloyd, the former less than 5 per cent., the latter over 30 per cent. of unprotected.

Table showing the condition of immigrants on arrival in this country during October, 1882, *with reference to their protection from small-pox.*

Steamship.	Line.	Name of surgeon.	Number of immigrants.			
			Inspected.	Protected.	Imperfectly protected.	Unprotected.
Abyssinia	Guion	.....	47	22	24	1
Adriatic	White Star	Murray	111	94	12	5
Alaska	Guion	Grew	89	72	16	1
America	North German Lloyd	Moir	625	595	30	.....
Amérique	Transatlantic	Leroy	107	77	30	.....
Amsterdam	Netherlands-American	Von Yssel	49	25	24	.....
Anchoria	Anchor	Finley	84	59	23	2
Arizona	Guion	Luttrell	198	137	58	3
Australia	Carr-Hamburg	.....	1	.....	1	.....
Baltic	White Star	Browne	111	93	17	1
Belgenland	Red Star	.....	44	38	6	.....
Bohemia	Hamburg-American	Kurtz	390	297	92	1
Britannic	White Star	Laughlin	95	75	19	1
British Crown	American	.....	45	32	13	.....
Bolivia	Anchor	.....	63	29	31	3
Canada	Transatlantic	Guichard	170	146	20	4
Castor	Royal Netherlands	Miltenberg	170	96	67	7
Catalonia	Cunard	Mason	84	74	10	.....
Celtic	White Star	Bateman	140	67	64	9
Cephalonia	Cunard	McCracken	224	178	31	15
Cimbria	Hamburg-American	Muller	223	114	107	2
Circassia	Anchor	Foulds	35	25	10	.....
City of Berlin	Inman	.....	17	11	6	.....
City of Brussels	do	.....	41	23	18	.....
City of Chester	do	Irvin	372	311	56	5
City of Montreal	do	Bateman	235	201	25	9
City of Richmond	do	Clarkson	44	37	7	.....
City of Rome	Anchor	Corder	144	118	23	3
Daniel Steinmann	White Cross (?)	.....	44	30	14	.....
Denmark	National	.....	10	.....	10	.....
De Ruyter	White Cross	.....	12	6	5	1
Devonia	Anchor	Milner	189	164	20	5
Donau	North German Lloyd	Goernaud	374	261	105	8
Depuy de Lome	Transatlantic	Shourd	7	2	4	1
Edam	Netherlands-American	Crump	7	5	2	.....
Egypt	National	Morrison	197	159	31	7
Elbe	North German Lloyd	Liedbegener	857	677	150	24
England	National	.....	6	5	1	.....
Erin	do	Daly	107	75	32	.....
Ethiopia	Anchor	.....	92	67	25	.....
Frisia	Hamburg-American	.....	3	2	1	.....
Geiser	Thingvalla	.....	333	101	208	24
Gellert	Hamburg-American	Ressfount	81	62	19	.....
Germanic	White Star	Brice	548	420	113	15
Hapsburg	North German Lloyd	Bosch	410	344	55	11
Helvetia	National	Neary	107	41	63	3
Herder	Hamburg-American	Rautenberg	104	72	30	2
Hermann	North German Lloyd	Walz	296	235	59	2
Illinois	American	.....	60	45	15	.....
India	Carr-Hamburg	Bender	210	159	48	3
Indiana	American	.....	60	38	22	.....
Island	Thingvalla	.....	419	192	219	8
Jason	Royal Netherland	.....	3	2	1	.....
Jan Breydel	White Cross	Morin	31	28	3	.....
Koln	North German Lloyd	Decker	306	161	145	.....
Labrador	Transatlantic	Letellier	199	124	68	7
Lord Clive	American	.....	50	14	30	6
Leerdam	Netherland American	Wright	38	26	12	.....
Main	North German Lloyd	Koethe	145	87	55	3
Neckar	do	Strubel	69	54	15	.....
Nederland	Red Star	Grayson	63	47	16	.....
Nurnberg	North German Lloyd	.....	135	103	30	2
Oder	do	Deutes	128	89	36	3
Ohio	American	.....	39	8	21	1
Paris	Cie. Com. Français	.....	168	132	31	5
Parisian	Allan	.....	111	41	70	.....
Parthia	Cunard	.....	122	96	26	.....
Pavonia	do	Manner	35	19	16	.....
P. Caland	Royal Netherland	Rhigetti	184	142	36	6
Pennland	Red Star	August	154	120	32	2
Pennsylvania	American	Raynor	20	8	12	.....
Periére	Transatlantic	Derricagaix	63	47	14	2
Pieter de Coniack	White Cross	.....	35	23	10	2

Table showing the condition of immigrants on arrival in this country, &c.—Continued.

Steamship.	Line.	Name of surgeon.	Number of immigrants.			
			Inspected.	Protected.	Imperfectly protected.	Unprotected.
Pollux	Royal Netherland		18	14	4	.....
Polynesia	Carr-Hamburg		188	95	92	1
Polynesian	Allan		103	36	67	.....
Republic	White Star	Callaghan	161	81	75	5
Rhein	North German Lloyd	Wohllebe	251	184	62	5
Rhynland	Red Star	Stockham	137	106	24	7
Saint Laurent	Transatlantic		54	38	16	.....
Salier	North German Lloyd	Bamberger	1,011	778	206	27
Samaria	Cunard		190	178	8	4
Sardinian	Allan		183	102	81	.....
Sarmatian	Allan		131	36	95	.....
Scandinavian	Allan		8	4	4	.....
Scythia	Cunard		21	13	8	.....
Servia	Cunard		2	2	.....	.....
Silesia	Hamburg-American	Fischer	238	212	26	.....
Spain	National	Montgomery	221	180	38	3
State of Georgia	State		5	4	1	.....
State of Indiana	State		17	13	4	.....
State of Nebraska	State		22	21	1	.....
State of Nevada	State		30	19	11	.....
State of Pennsylvania	State	Blake	83	27	49	7
Stella	Royal Netherlands	Gutman	61	34	23	4
Strassburg	North German Lloyd	Scharff	490	350	132	8
Suevia	Hamburg-American	Hempricht	248	222	24	2
Switzerland	Red Star (?)	Bourke	152	88	63	1
Thingvalla	Thingvalla	Lachrisson	245	86	148	11
Vandalia	Hamburg-American		4	1	3	.....
Warwick	Bristol		31	21	7	3
Werder	North German Lloyd		3	3	.....	.....
Werra	North German Lloyd	Dombrowski	546	371	152	23
Westphalia	Hamburg-American	Teutzler	147	105	40	2
Wieland	Hamburg-American		129	92	33	4
Wisconsin	Guion	Crichton	65	24	39	2
Wyoming	Guion	Barre	5	5	.....	.....
Zaandam	Netherlands-American	Obdam	90	53	37	.....
Zeeland	Red Star	Lutz	235	194	35	6
Tolals			15,999	11,271	4,378	350

The following comments of the inspectors will aid to a more intelligent appreciation of the foregoing figures. It should be borne in mind that these are the inspectors' day-to-day observations, no individual one of which may be taken as conclusive evidence of the general character of the passengers of any given vessel. A group from a vessel to-day, for example, may present a very marked contrast to another group from the same vessel met with to-morrow.

Bohemia, Hamburg-American line.—Dr. Kurtz, surgeon of the Bohemia, had inspected his passengers, and revaccinated many of them with good results.

Ethiopia, Anchor line.—People all found protected by typical or modified vaccination or previous attack of small-pox.

City of Chester and City of Montreal, Inman line, and Samaria, Cunard line.—Passengers all bore evidence of good work by ships' surgeons. In one arrival of 195 immigrants by the City of Chester, Surgeon Irvin had successfully vaccinated or revaccinated 145, and 35 had been successfully vaccinated before sailing.

India, Carr-Hamburg line.—Surgeon Bender; 142 passengers—46 recent European vaccinations, 62 ship vaccinations, 32 required revaccination by Western inspector, and 2 unvaccinated adults. There were no adult revaccinations among this number.

Salier, North German Lloyd.—Surgeon Bamberger; 510 passengers—500 ship vaccinations, 370 successful, 130 revaccinated by Western inspector.

Koln, North German Lloyd.—Surgeon Decker; 306 passengers—227 ship vaccinations, only 82 successful.

Parisian, Allan line.—Could not learn that any inspection had been made by the ship's surgeon, nor were there any evidences of ship's vaccination.

Sarmatian, Allan line.—No evidence that surgeon had paid any attention to the matter.

Polynesian, Allan line.—Found no trace of vaccination or inspection on shipboard.

Sardinian, Allan line.—Nothing had been done on shipboard.

[From these four steamers there were received 528 immigrants, who were either entirely unprotected or imperfectly protected against small-pox].

Pieter de Coniack, White Cross line.—Nearly 30 per cent. of ship's vaccinations were failures.

Cephalonia, Cunard line.—Of 156 passengers, 52 were found protected by recent European vaccination, 62 by ship's vaccination, 29 required revaccination, and 13 (adults) had never been vaccinated at all. This surgeon appears to have periods of good and of bad work.

Ohio, American line.—Surgeon had made no inspection, so far as I could ascertain; gave no cards, and did no revaccinating of adults.

Lord Clive, American line.—The surgeon had made no inspection, issued no cards, and did no revaccination.

Canada, Transatlantic Steamship Company.—Surgeon Guichard had inspected his people October 17, but "I found no adults revaccinated by him among those on this train."

Pennsylvania, American line.—No adult revaccinations.

British Crown, American line.—There had been no examination by the surgeon, no cards had been issued, and no adults had been revaccinated.

Egypt, National line.—Dr. Morrison; inspection not very thorough or complete.

Amsterdam, Netherlands-American line.—Surgeon Von Yssel does not appear to have vaccinated the adults. "I vaccinated a child three years of age, upon whom I could find no vaccine cicatrix, and I understood the mother to say that it never had been vaccinated. It had a card from the ship's surgeon, and one from the inspector of New York State board of health, both of which I herewith inclose, marked B. H."

Nederland, Red Star line.—Surgeon Grayson's inspection of his people, October 4–5, had been thorough. He had revaccinated those adults who needed it. I saw none with typical results.

Rhynland, Red Star line.—Dr. Stockham's inspection, September 28, thorough, and good results in his adult revaccinations.

Paris, Campagnie Commerciale Francais.—People had come from Italy; inspection very thorough; adults had been revaccinated.

Baltic, White Star line.—Surgeon Browne's inspection a model of thoroughness; adults revaccinated with finely typical results.

Suevia, Hamburg-American line.—Surgeon Hempricht's people had been carefully inspected, and those needing it had been revaccinated. Of 126 revaccinations there were found 70 typical results, 41 modified, and 15 failures.

Oder, North German Lloyd.—Inspection thorough, and adults revaccinated. "Saw one man presenting a typical vaccine cicatrix on left arm, done in infancy, and who now had seven typical insertions progressing normally on his right arm. They had been done by puncture of needle apparently, and were, both in respect of numbers and quality, the best that I have ever observed done in that way."

Labrador, Transatlantic Steamship Company.—Surgeon Lettelier had examined the arms of his immigrants, and I saw one young woman whom he had revaccinated. "As a rule I have very rarely found that surgeons of this company ever do any revaccinating. Upon four who claimed to have been revaccinatedby very fine puncture, I could find no trace of any operation."

Another inspector reports finding on one train 60 vaccinations by this surgeon, of which 17 were failures, 20 had modified and 23 typical results.

Elbe, North German Lloyd.—Surgeon Liedbegener's inspection had been thorough; found none who had not been revaccinated. His method was that of vaccinating by needle, making three to five punctures, thus : . :

Neckar, North German Lloyd.—Surgeon Strubei's inspection very thorough; found no adults not revaccinated. His method of vaccinating same as above described.

Main, North German Lloyd.—Inspection rigid, and numerous excellent adult revaccinations, showing typical results.

City of Rome, Inman line.—Inspection good; some of the adults showed typical revaccination by the ship's surgeon.

City of Richmond, Inman line.—The surgeon, Dr. Clarkson, had made some very fine typical adult revaccinations.

Hapsburg, North German Lloyd.—Dr. Bosch's inspection thorough. The results of adult revaccination were not so uniformly good as those generally done by surgeons of this line.

Erin, National line.—Surgeon Daly's inspections good; some typical adult revaccinations.

Rhein, North German Lloyd.—Inspection very thorough, with numerous excellent adult revaccinations. "Found one man from this ship, 46 years of age, who had been revac-

cinated by the surgeon in three places; the vesicles were typical in every respect, though he had had confluent small-pox."

Gellert, Hamburg-American line.—Inspection had been very thorough; all adults seem to have been revaccinated, and the method was good, thus | | | . In regard to the material, many of the insertions promised to become effective; was told they had only been done just before landing, on or about October 2.

State of Indiana, State Steamship Company.—Surgeon appears to have examined the arms, but found no signs of adult revaccinations.

Germanic, White Star line.—Noticed no adult revaccinations.

Herder, Hamburg-American line.—Surgeon had inspected his people and done a large number of adult revaccinations; the results were generally very poor. "In my judgment his method was faulty; the insertions were only of the size of the point of a pin."

Periére, Transatlantic Steamship Company.—Inspected on board September 28 by Surgeon Derricagaix. Found not one adult revaccination.

Amsterdam line.—Found 71 entirely unvaccinated by steamship surgeon, of which 51 were not suitably protected.

Amérique, Transatlantic Steamship Company.—Surgeon Leroy's people had been inspected; saw no adult revaccinations.

Polynesia, Carr-Hamburg line.—Inspections had been, as a rule, thorough; some of the adults had been revaccinated, but results were generally poor; the insertions were made thus ·. ·—about size of a needle point. "I vaccinated a child six months of age who had been provided with a card, though it had not been vaccinated."

Arizona, Guion line.—People had been inspected; they said no adults had been revaccinated, so far as they knew, but that the children needing it had been vaccinated.

Westphalia, Hamburg-American line.—Dr. Teutzler had inspected the people pretty thoroughly and had revaccinated most of the adults. The results were variable, as though his vaccine material was not equally effective. His method was by latitudinal incisions, thus ═══.

Denmark, National line.—Surgeon had made an inspection of his people. "I have no notes of finding any adult revaccinations."

Scythia, Cunard line.—People showed typical scars of revaccination by ship's surgeon.

Zeeland, Red Star line.—Surgeon Lutz's inspection had been thorough; adults generally revaccinated; results excellent.

Werna, North German Lloyd.—Surgeon Dombrowski's inspection had been extremely thorough. He revaccinated all his adults with excellent virus and had secured a large proportion of typical and modified results.

Donau, North German Lloyd.—Surgeon Guernaud's inspections had been thorough. Adults very generally revaccinated; one man, 30 years of age, who had on each arm four typical vaccine cicatrices, had been revaccinated, and showed the operation progressing in a perfectly typical manner. The comments on the steamer Werra apply equally to the Donau.

Thingvalla, Thingvalla line.—The immigrants arriving by this line are, as a rule, the most poorly protected of any arriving in the western district. Of 170 found on one train, October 15, only four had been vaccinated by Surgeon Lachrisson, of the Thingvalla, and these were all failures. It was deemed necessary to revaccinate 110 of the 176—five of them being primary.

Pennsylvania, American line.—Dr. Raynor had inspected his people and done some adult revaccinations.

"Upwards of two-thirds of the immigrants (Scandinavians) on this train had been landed at Philadelphia from the steamer Illinois, of the American line. After careful inquiry and inspection, assisted by an immigrant who could interpret fluently for me, I came to the conclusion that there had been no inspection whatever, and that no adults had been revaccinated on shipboard. Five of these people came and asked me to vaccinate them."

"I vaccinated a boy eight months of age, who had a card issued by the surgeon of SS. Polynesia. Sometimes the cards become interchanged, and it is barely possible that the child had not been inspected at all. I have myself occasionally had to remove a great many bundles from the seat of a car in order to discover a child who had been hidden by its parents to avoid the trouble of getting its arm ready for inspection."

During the week ended October 21 there arrived, via the Baltimore & Ohio Railroad, 115 passengers, landed at Baltimore by the steamer Strassburg and America, of the North German Lloyd. Surgeon Scharff, of the Strassburg, had performed 450 vaccinations, only a very few of which were successful. On the other hand, out of 595 vaccinations performed by Dr. Moir, of the America, all but 30 were successful. Of the Strassburg's people it was deemed necessary to revaccinate 179.

Out of 41 passengers in one car, by the steamer Oder, of the North German Lloyd, 40 had been vaccinated on the steamer and only one entirely successfully. Another inspec-

tor reports finding three adults who had never been vaccinated, but who presented protection cards from this vessel, bearing Surgeon Deutes's name. According to other passengers, they had obtained them on the road.

In another case six immigrants, adults, never vaccinated, presented cards of the steamer Labrador, of the Transatlantic Steamship Company, Surgeon Letellier, also asserted to have been obtained in the same manner as those of the Oder.

In one group of 25 passengers by steamer Castor, Royal Netherland line, Surgeon Miltenberg, there were found six who had never been vaccinated.

"On the 17th of October I found 12 persons bearing cards from the National line having no date, port of entry or departure, no name of passenger, no name of steamer, and 7 of the 12 had never been vaccinated."

"On the 31st I found a car load of persons having ship tickets, simply marked *Protected*—no name of line, steamer, port, or passenger, and no date; seven of the thirty-one were unprotected, three of them never having been vaccinated."

As the weather grows colder and the days shorter, more care is required to keep railroad cars in a cleanly condition, and properly ventilated. The inspectors note from time to time some laxity in this respect, even upon the best managed roads; but the evil seems to be most marked in cars transferred from other lines to our trunk lines. For example, one inspector, speaking of a train on the Pittsburgh, Fort Wayne and Chicago Railroad, says: "It had two cars of the New York, Pennsylvania and Ohio Railroad, and ninety-three immigrants. It was said that the cars had been brought to Mansfield, Ohio, attached to a freight train, but of this I have no knowledge, personally. The cars were dirty, and water-closets had bad odor. The people did not seem to be up to the average lot of immigrants in physical, social, or personal condition. I found it necessary to revaccinate forty-one, and to vaccinate three."

Another one says: "Two cars from the Great Western on one of the trains of the Michigan Central Railroad presented a marked contrast with the cars of this company used in the immigrant transportation. They were filthy and absolutely without illumination, although they arrived several hours after dark."

In a car on the Indiana, Bloomington and Western Railroad the Indianapolis inspector found the body of a girl, 12 years of age, who had died of diphtheria the day previous. The mother said the child had been sick from the time of landing in New York. The inspector had the body disinfected and removed in an air-tight coffin, the clothing destroyed, the car emptied, cleansed, and disinfected, and the immigrants placed in a clean car and sent on their journey.

The inspector on the Baltimore and Ohio Railroad, on the 21st of October, found a Scandinavian woman who had given birth to a child about two hours before his arrival. She was bleeding profusely and was almost moribund. He succeeded in arresting the hemorrhage, and as she was too weak to continue her journey he had her suitably cared for on arrival in Chicago.

One inspector notes the arrival of a woman by the Cunard steamer Samaria, bound for California, who presented symptoms "suspiciously like those of leprosy."

Among the correspondence received during the month I beg to refer to an extract from the remarks of Dr. W. M. Smith, health officer, port of New York, in which, speaking of certain vessels specified in reports submitted to him, he says: "The records of the surgeons of these ships throw suspicion on their fidelity to the rules they are required to follow. The agents and owners will be notified of the intention of the authorities to detain these vessels at their next entry to this port long enough to examine the work of the surgeons."

If this step be vigorously followed up it will do much to remedy the evils of which I have found it necessary to complain. The health officers at the various ports of entry have it in their power to reduce the importation of contagious disease to the minimum. That this action of Health Officer Smith is not the rule rather than the exception is due probably to the pressure brought to bear by commercial interests against any measure which involves delay, no matter how essential it may be from a sanitary stand-point. In this work, however, there need be little if any delay, if only those interested will comply with the very reasonable requirements, which have been so often detailed.

Surgeon Guichard, of the Transatlantic Steamship Company's steamer Canada, thinks it would be well to define accurately the expression "sufficiently protected," adding that the majority of those who bear any evidence of vaccination claim that the operation was recently performed. In response to the doctor's suggestion I offer the following extract from a circular recently issued by order of the Illinois State Board of Health concerning the vaccination of school-children in this State:

"Scholars * * * must present to the teacher (*a*) certificates of proper vaccinal protection; or (*b*) certificates that they are protected by previous attacks of small-pox or varioloid; or (*c*) that they are insusceptible to vaccination; or (*d*) that their physical condition is such as to make it imprudent to vaccinate at the present time.

"*Proper vaccinal protection* means a successful vaccination in a child not yet arrived at the age of puberty; or, if beyond that age, a successful vaccination or revaccination, as the case may be, performed within the past two years (approximately).

"The certificates above described must be signed in all cases by legally-qualified physicians."

It is probably impracticable for a steamship surgeon to demand the certificate above described; but for all practical purposes he can satisfy himself of the material facts by personal inquisition. In cases of doubt as to the date of a revaccination or as to insusceptibility, his duty would be to revaccinate.

Attention has been asked to certain "grave errors" in the names of steamers and lines in my September report. The steamer Edam was accredited to the Royal Netherland Steamship Company, instead of to the Netherland American Steam Navigation Company; the steamer Australia and the steamer Leipzig to the Hamburg-American Packet Company, instead of to the Carr-Hamburg line and the North German Lloyd, respectively; and the Gen. Herder was misprinted Gen. Werder. The last error is probably inexcusable, but it is not difficult to conceive that the other mistakes might easily occur to the most painstaking inspector under the conditions which obtain in crowded immigrant trains. In the table above given, however, it is hoped such errors have been avoided.

Appended will be found the usual table showing the number of inspections and of vaccinations by each inspector for the month of October, and for the total period, June 1 to October 31. For purposes of comparison the totals for the month of September are also given.

I am, sir, very respectfully,

JOHN H. RAUCH, M. D.,
Supervising Inspector.

CHARLES SMART, *Surgeon, U. S. A.*,
Secretary National Board of Health, Washington, D. C.

IMMIGRANT-INSPECTION SERVICE, N. B. H.—WESTERN DISTRICT.

Inspections and Vaccinations by the Assistant Inspectors, June 1–*October* 31, 1882.

Stations.	September.		October.		June 1 to Oct. 31.	
	Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.	Number inspected.	Number vaccinated.
Pittsburgh, Fort Wayne and Chicago Railroad	2,560	618	2,522	390	17,347	2,539
Lake Shore and Michigan Southern Railroad	2,179	396	2,609	265	14,011	2,285
Michigan Central Railroad	2,839	1,006	3,199	1,140	22,330	6,145
Grand Trunk Railroad*	949	64	1,119	124	9,356	1,875
Baltimore and Ohio Railroad*	1,747	402	2,495	603	10,688	2,348
Indianapolis†	3,029	294	3,333	782	13,746	1,635
Saint Louis	1,101	138	1,196	49	7,361	368
Totals	14,404	2,918	16,473	3,353	94,839	17,195

*Inspection began June 5.

†Inspection began June 20.

R. M S. GERMANIC,
New York, November 6, 1882. *Foot of Tenth street.*

CHARLES SMART, Esq., *Major and Surgeon, U. S. A.,*
Secretary National Board of Health, Washington, D. C.:

SIR: I have the honor to acknowledge the receipt of a letter from yourself bearing date October 17, in which you recommend early vaccination of passengers after leaving port, and which contained two printed slips in which myself and many other seafaring surgeons are gibbeted for supposed non-compliance with the orders of our respective companies (with whom alone *we* have really to do) as regards the inspection and vaccination marks and the revaccination of those who do not possess them.

In reference to your own suggestions, I respectfully point out to you that when the ship leaves Queenstown, her last port of departure, and plunges into a heavy head sea, as is *most frequently* the case, it is impossible to go down into the steerages, crowded with miserably sea-sick and undisciplined people (often above a thousand in number) and perform the operations you desire. Apart from which would be its positive cruelty. We have not sufficient power at our command to compel compliance with such a rule, and if we did use force it is doubtful, as matters now stand, whether we should not render ourselves liable to legal proceedings on arrival at New York. Furthermore, taking into consideration the skeptic influences which must prevail among a crowd of unwashed, poverty-stricken people, massed together as they necessarily are under conditions which cannot, with wind and sea ahead, be altered or improved, it is the opinion of those of us who have had large experience of emigration and emigrants that an outbreak of erysipelas might readily occur—a repetition in fact (on a serious scale) of the recent disaster in Norwich, England, for an account of which I refer you to the British Medical Journal of last month. These are questions worthy of grave consideration.

As regards the posting of our names by the gentlemen out west I have only to say that it is most unfair. From the slips I received I can gather no positive information as to the number of small-pox cases *among the emigrants* passing west. The prominence given to the case of the woman mentioned leads me to the supposition that they are very few in number. I *know* that very few cases occur on the Atlantic. The number of cards without surgeon's name seems to show that they have been obtained by interested parties, surreptitiously. I keep my own under lock and key, but others may not be so careful, or they may be obtained ashore. There is no Dr. King in the Cunard service. State compulsory revaccination is not enforced in any European country any more than it is in America. Hence one difficulty with our people. They point to their vaccination marks. We are ordered to look for vaccination marks. Are we to hand faintly-marked cases to the quarantine authorities? I have received no such instructions. It is impossible to examine the women and children on deck, and no ship has a steerage as well lighted as the waiting-room of a railway depot. For myself, I can conscientiously say that I examine every arm in the steerages, and if the inspector had our positions and surroundings even they would not escape an occasional error. They would be surprised, too, if they saw the difficulty we have to get our passengers to submit to inspection even in the finest weather, especially those who have been in America before, and who largely influence others. We have to coax, expostulate, and threaten, and this occurs with wearisome iteration, voyage after voyage.

In conclusion (although this has no direct bearing on the question between us), I may say that the only serious epidemic of small-pox I have had to contend with at sea, in an experience of nearly thirty years, was on the Cunard steamship Parthia, on her first voyage *from* New York to Liverpool, when I had twenty cases and three deaths.

Finally, I positively assert that no vaccination card has ever issued from this ship, to my knowledge, without my signature or that of the assistant surgeon.

Your obedient servant,

J. FOURNESS BRICE, *Senior Surgeon Germanic,*
M. D. Coll. Phys. and Surg. N. Y., M. R. C. S. Eng., &c.

It was utterly impossible to vaccinate the people this voyage until the Wednesday before arrival. We had heavy weather until we reached the Banks of Newfoundland. There was much sea-sickness.

TABLE.—*Showing by weeks from June 1 to October 28, 1882, inclusive, the number of boats and trains and of immigrants inspected at Detroit, Mich., the number of immigrants passed by reason of old vaccinations, the number recently vaccinated in whom it was working, and the number not working; the number of primary and of secondary vaccinations performed, the number of passes examined and issued, and the number of persons sick in transit, and some of the causes of the sickness.*

Week ending—	Boats and trains inspected.	Immigrants inspected.	Immigrants inspected who had—				Vaccinations performed.			Passes.*		Sick in transit.	Cases of measles.
			Old vaccinations and were passed.	Previously had small-pox.	Recent vaccinations working.	Recent vaccinations not working.	Primary.	Secondary.	Total.	Examined.	Issued.		
June 3	7	1,745	.....	.....	.....	.....	.....	.....	2	.....	.....	1	1
June 10	16	2,605	.....	.....	.....	.....	.....	.....	6	.....	.....	8	6
June 17	15	1,742	.....	.....	.....	.....	.....	.....	1	.....	.....	3	1
June 24	13	1,644	.....	.....	.....	.....	.....	.....	7	.....	.....	12	8
July 1	13	1,608	.....	.....	.....	.....	.....	.....	6	.....	.....	2	1
July 8	12	2,179	982	19	71	163	2	0	2	1,870	309	3	2
July 15	15	1,210	970	26	218	93	26	3	29	857	353	7	5
July 22	15	728	630	15	37	44	19	7	26	575	147	6	6
July 29	15	1,927	1,715	36	141	115	11	69	80	1,668	246	0	0
August 5	15	538	467	11	26	28	5	24	29	438	72	0	0
August 12	14	950	864	21	34	31	17	32	49	826	114	2	0
August 19	17	748	679	26	52	60	18	15	33	705	41	1	1
August 26	14	500	461	18	21	10	5	15	20	466	34	0	0
September 2	16	983	820	21	67	32	13	41	54	843	100	0	0
September 9	14	693	600	20	62	16	9	23	32	608	66	‡3	0
September 16†	13	1,264	571	22	37	28	16	27	43	568	50	0	0
September 23	11	932	730	16	20	35	6	78	84	713	95	0	0
September 30	9	905	853	14	20	27	3	29	32	856	44	0	0
October 7	6	602	564	10	56	27	27	12	39	560	42	0	0
October 14	8	779	393	11	31	40	15	4	19	370	25	0	0
October 21	13	668	515	16	61	69	11	8	19	513	19	0	0
October 28	7	907	845	20	93	35	16	2	18	879	31	0	0
Totals, 22 weeks.	278	25,857	12,659	322	1,047	853	219	389	630	13,315	1,788	48	31

* Cards certifying the holders were vaccinated or otherwise protected from small-pox.

† Of the 1,264 inspected this week, 646 were Mormon immigrants, who were all provided with vaccination cards from the ship's surgeon. They were closely inspected, but the time allowed—the railroad company not having given the usual notice of their arrival—prevented an indorsement of all the cards or the inspection of all the arms. The intelligent agents who traveled with them assured us that fully 70 per cent of the ship vaccinations were working, and the proportion of those inspected corroborated this statement.

‡ Whooping-cough, 3 cases.

J. J. MULHERON,
Inspector.

HEALTH OFFICER'S DEPARTMENT, STATE OF NEW YORK,
Quarantine, S. I., September 30, 1882.

Secretary National Board of Health:

DEAR SIR: In a recent communication (September 23d inst.) you impliedly invited an opinion as to the desirability of continuing the inspection of emigrants.

So far as relates to their inspection with reference to their protection by vaccination at the maritime quarantines, and particularly at the New York quarantine through which about 75 per cent. of emigrants pass, there can be but one opinion. The necessity is greater, in my opinion, than the measures for the exclusion of yellow fever. In proof of this allow me to refer you to a subjoined extract from a paper read at a meeting of the New York State board of health in 1881.

* * * * * * *

"But quarantinists have to deal with yet another form of disease less exclusive in its habitat, quite as certain in the effect of its contagion, more loathsome in its development, and oftentimes scarcely less fatal in its results. Variola, popularly known as small-pox, is an established disease in our country, and its forces are too often recruited from the pest-houses of the old world. Statistics show that the fatality from this disease during a number of years past has been greater in the United States, Mexico, many European cities, and some parts of the West Indies, which are the perpetual homes of yellow fever, than from any and all the diseases to which reference has been made. The number of cases of small-pox occurring in New York city for six years previous to January, 1876, was 11,310; the number of deaths from this disease for the same period was 3,908. The number of recorded deaths from the same cause in the city of New York for the seventy-two years preceding 1876 was 15,571, and the record is admitted not to do justice to the number. The number of cases reported in New York for the year ending July 31 ultimo was 1,042, and the number of deaths 352, being 33 per cent. In Philadelphia the deaths for the same period were 1,412; on the basis of the percentage of New York the number of cases was 4,179. In Havana the number of deaths from small-pox in February, 1881, was 89, and only 5 from yellow fever. In March 110 deaths from small-pox were reported as against 3 from yellow fever. It is the concurrent testimony of statistics that the yearly aggregate of deaths from this disease in the United States far exceeds all other diseases against which maritime quarantine is designed to guard.

"In view of this fact, and that there is no disease of a contagious or infectious character which is domesticated, as it were, among the people by their ignorance and neglect, where source and preventative treatment are as well understood, the indifference of the people and of their accredited representatives in legislative bodies and boards of health in time past is a matter of infinite surprise to the intelligent sanitarians of to-day."

Emigration to the United States from European countries is an established condition, which must be taken into consideration by health authorities in the future. With reference to this view, may I trespass on your attention by further reference to an extract from the paper before referred to?

* * * * * * *

"IMMIGRATION"—AN IMPORTANT SUBJECT CONSIDERED BY THE HEALTH OFFICER OF THE PORT OF NEW YORK.

At the recent quarterly meeting of the State board of health, held at Niagara Falls, Dr. William N. Smith, health officer of the port of New York, read a paper on "The sanitary problem connected with immigration." A very important subject was so ably considered that the board unanimously passed a resolution requesting the publication of the paper. Dr. Smith, however, desired time to revise it, as some portions had been written hurriedly and in pencil. He has forwarded it to The Express, and as the subject is one which very nearly concerns our own city and people, we take pleasure in presenting the matter to our readers:

Dr. Smith's paper.

A consideration of some of the sanitary conditions connected with immigration as they now exist, and the necessity of their improvement, is a subject of too much importance to the people of this State, and, indeed, of the United States, not only at the present time, but for a length of time, as will be shown, which must be measured by generations instead of years, if the political and economic elements of the problem continue to be what they now are and give promise of continuing to be, and demands the earnest attention not only of the legal guardians of the public health as constituted under State and municipal laws, but by the noble, self-sacrificing humanitarians who have already distinguished this age by their efforts in behalf of sanitary reforms.

That emigration from the Old World to the New is an established fact and an increasing tendency which only great and disorganizing upheavals in our social or political systems can interrupt, needs only the proof which a brief statistical history of it affords.

For sixty years past the records of emigration to this country are reliable, Congress having provided in 1819 for a record of all arrivals from foreign countries. Estimates only can be given of the number of emigrants to the United States for the period intervening between that date and the organization of the Federal Government. The estimate of 250,000 aliens during this period is generally accepted as correct.

Ten millions six hundred and sixteen thousand emigrants have landed upon our shores since 1820. The tide has from year to year been steadily increasing, scarcely checked even during the years of our great civil war; during the period of its greatest severity (1863) footing up a total of 176,282. The number arriving at the different ports of the United States in 1880 was 673,636.

The immigration through the port of New York affords the most striking view of the proportions which it has assumed from one stand-point. The total number of immigrants arriving at that port in 1880 was 327,371.

The first five months of the present year (1881) 181,749 immigrants passed the New York quarantine. The number arriving in May alone of the present year was 76,812. Should the rate of immigration for the past five months continue the balance of the year, the enormous number of 400,188 will have landed at Castle Garden alone.

It is evident from this brief review that emigration to the United States is not dependent on accidental conditions, or the result of spasmodic efforts to relieve the surplusage of European countries. It must be considered as a certainly established and important factor in the civilization of our age, and treated as such by those who have the best interests of the whole people at heart in their varied relations. In a particular manner, as we shall see, the legally-constituted custodians of the lives and health of our citizens are competent, and to that extent responsible for the adoption of measures which, so far as possible, shall protect the one and preserve the other.

* * * * * * *

"Immigration has been shown to be an established fact. Economic and political conditions have made it such. The same causes will continue for many years to come to influence the crowded populations of Europe and the British islands to emigrate. We are accustomed to think that the proportions which immigration has assumed in the few last years will speedily result in 'filling up the country,' and that from this cause alone it must cease or materially diminish. The mind fails to comprehend the vast territorial extent of the United States unless aided by comparative illustrations. Its periphery, exclusive of Alaska, is 11,000 miles—only 1,500 less than half the circumference of the globe. In area it embraces 3,611,849 square miles and a population in round numbers of 50,000,000, being 13.8 persons to the square mile. France, with a population of 40,000,000, has an area of 203,811 square miles, and supports with thrift and prosperity 196.2 persons to the square mile. The United States may therefore increase its population nearly fourteen times, or until it reaches the enormous number of 600,000,000, before it equals in density of population that of the French Republic. It may safely be assumed that the broad and fertile prairies, the vast forests, and the countless millions of wealth in mines which yet await development and invite the strong arms and willing hearts of the immigrant will contribute to increase rather than diminish the tide which is invigorating the New World at the expense of the Old."

The plan or system now adopted of securing vaccination before the embarkation of the emigrants, and their early examination after embarkation and vaccination by the ship's surgeon of all the unprotected, or insufficiently protected persons, is the result of much time and effort with the agents and owners of transatlantic passenger lines at this port on the part of the undersigned. The experience of the past six or eight months conclusively proves three things: 1st. At no place in the interior can protective measures be of as much service as those which are secured by the examination and vaccination of emigrants before or soon after they leave the port of departure. 2d. Coercive measures to secure vaccination cannot be enforced with any certainty except by the health authorities at the port of entry, and by them before the vessel is released from quarantine. 3d. The results at this quarantine prove the great service of the system adopted, as the following statement will show:

The report of the commissioners of emigration shows that in 1879 135,070 emigrants arrived at the port of New York. The report of the health officer (Dr. Vanderpoel) to the commissioners of quarantine for that year says: "Few arrivals of cases of small-pox have occurred; seven in all." Since the 27th of April 266,930 emigrants by transatlantic steamers have entered this port, with not a single case of small-pox.

This is a striking and favorable contrast with the experience at this quarantine for any similar period previous to the adoption of the plan now enforced—certainly during my administration.

It must be apparent that the great object is to secure the vaccination of passengers previous to or soon after the embarkation of the passengers. As no law can compel except as the penalty is made operative at the port of arrival, and as its violation or neglect can be determined only by great watchfulness, which will require frequent re-examination of the arms of every passenger, it must be evident that to maintain the system will require far more work at this quarantine than previous to its adoption. If it was not for the fear of the ship's detention at quarantine for the correction of omissions of the surgeon, there would not in three months' time be any practical benefit from the plan adopted.

After so much effort, and the accomplishment of so much in the way of co-operation on the part of the owners and agents of the transatlantic passenger lines at the port of departure, I should regret to see the system abandoned, as it certainly will be without the co-operation of the National Board, or some other authorized department of the general government.

If the quarantine officials at the ports of entry for emigrants execute the law to the extent of their ability, I look to see the "owners and managers" of emigrant passenger ships at no distant time make the vaccination of passengers, or the evidence that they are sufficiently protected thereby, a *sine qua non* to their securing passage.

If my views are correct, it would be far better to abandon all interior inspections than those at the principal ports of entry for emigrants. But I would not be understood as advising the abandonment of a few focal points in the West. The necessity of these I have maintained for more than two years past in several published articles in the New York papers.

The reduction of Dr. Hanor's salary for the month of October will be made good to him by me, as he was hired with the distinct understanding and approval of Dr. Stephen Smith, that he should be paid $200 per month.

Very truly yours,

WM. M. SMITH,
Health Officer, Port of New York.

APPENDIX N.

QUARANTINE AT SAN FRANCISCO, CAL.

1. **LETTER OF F. A. BEE, CHINESE CONSUL, ON THE CASE OF THE ALTONOWER.**
2. **EXTRACT FROM PETALUMA ARGUS.**
3. **EXTRACT FROM BERKELEY BEACON.**
4. **REPORT ON QUARANTINE AT SAN FRANCISCO, CAL.**
5. **LETTER FROM COMMITTEE OF BOARD OF HEALTH, SAN FRANCISCO.**

IMPERIAL CHINESE CONSULATE-GENERAL,
San Francisco, June 6, 1882.

Dr. T. J. TURNER, U. S. N.,
Secretary National Board of Health, Washington, D. C.:

SIR: Prompted by the dictates of humanity, as well as believing it my duty as the representative of the Imperial Government of China, I desire to call the attention of the National Board of Health to the following facts in connection with the so-called quarantine arrangements of this port.

There arrived here from the port of Hong-Kong, China, on the 6th of May last, an English steamship named the Altonower, having on board over 800 Chinese passengers. Before examination it was found that there was *one case* of small-pox on board.

Without entering into details the ship was put in quarantine and the sick man removed to the pest-house, as neither the State nor local government has provided facilities for the care of immigrants arriving here with infectious and contagious diseases among them, not even a shed on shore, in fact nothing has been done by the health authorities in the way of providing quarantine facilities for the protection and preservation of the public health. The custom now in vogue is, when a ship arrives with infectious disease on board the consignees are informed that they must take charge and provide for them on board. For instance, the Altonower has been in quarantine (so called) for thirty days with 800 human beings shut up within her iron walls, a mere freight vessel, illy adapted for passenger traffic, with no ports for ventilation; it can be imagined in what an inhuman and horrible situation these poor, friendless strangers are placed, crowded into this veritable "lazar" vessel.

To the credit of the consignees (one of the oldest and most respectable firms, Macondray & Co.), it can be said they have done everything in their power to alleviate this condition of things. They have offered to transfer the passengers to an old ferry-boat where they could be properly cared for, but all overtures have been neglected by the board of health of this city, notwithstanding Macondray & Co. offered to give bonds for the support and care of the Chinese passengers. It is with regret I make the assertion, but every sane person resident in this city and State is fully convinced that were these 800 immigrants Europeans this outrage would never have been tolerated, but to the contrary they would have been provided for in a very different manner, and that promptly. That this case has no parallel or precedent within the confines of this country is true. There is no one brave enough to raise a voice in denunciation, not even those "who preach Christ and Him crucified," dare utter a word of protest from the pulpit. The only exceptions are the inclosed slips from country papers, which forcibly state the facts.

In thus briefly calling the attention of the National Board of Health to this matter, I do so under the belief that your functions extend over the whole country and that it is a part of your duty to protect the public health whenever it is necessary. If there is a

seaport in the United States that demands the attention of your board it is the port of San Francisco, that proper conveniences be provided for the treatment of contagious diseases, and that those affected may be treated in a humane manner becoming to a Christian nation and people. Trusting that in thus calling your attention to this matter your honorable board may take such action as seems just and proper, I have the honor to be with much respect,

Your obedient servant,

F. A. BEE,
Chinese Consul.

[From the Petaluma Argus.[

A PEST-STRICKEN SHIP.—The British ship Altonower reached San Francisco a fortnight since with about nine hundred Chinese passengers. As there was a case of small-pox on board, the vessel was quarantined.

The disease has spread among the passengers, and some 40 afflicted with the loathsome disease were transferred from the vessel to the pest-house in San Francisco.

The health officers of that city have, however, refused to allow any more of the pest-stricken Chinamen to leave the ship. As a consequence, the Altonower is now literally a floating pest-house, there being not less than 50 cases of small-pox on board at the present time, and new cases developing daily. This condition of affairs ought not to exist in the principal harbor of any civilized country. *There are several islands in the San Francisco Bay where passengers from pest-stricken vessels could be humanely provided for without any danger of contagion to the city.* If an immigrant ship in New York Harbor was to be placed in the pitiable condition of the Altonower it would cause a hiss and hoot the world over. That these unfortunates on this pest-stricken ship are Chinamen in no wise mitigates or excuses their being kept huddled together on ship-board to die like brutes. *If a vessel was to reach San Francisco ladened with Sonoma County calves in as deplorable and suffering condition as are the passengers of the Altonower, the dailies of that city would make swift haste to demand that the Society to Prevent Cruelty to Animals should take prompt action in the matter.*

The Alta did, on Tuesday, enter a feeble protest against the iniquity, and for its temerity was jeered by a contemporary in this wise: "Our weak but tender-hearted contemporary, the Alta, would land the coolies from the Altonower at some improvised quarantine grounds on Goat or Angel Islands." Weak but tenderhearted! Is it any source of pleasure or gratulation to the press of that city that these unfortunates, cooped up on the Altonower, are liable to be decimated by a pestilence the breath of which they are as powerless to escape as is the bullock to elude the blade of the slaughterer? In this matter they are pandering to a morbid and unworthy sentiment which has no substantial root deep down in the nobler attributes of humanity.

[From the Bulletin June 6.]

THE QUARANTINED ALTONOWER.—Two new cases of small-pox were discovered yesterday morning on board the Altonower, both Chinamen. They were towed in a boat to the Twenty-sixth street hospital by the quarantine launch, Governor Perkins. The Altonower has been in quarantine thirty-one days, at a cost of fully $400 a day, and she must remain in quarantine at least thirty days more.

[From the Beacon, Berkeley.]

MERCY TO THE PLAGUE-STRICKEN.—What a strange thing is sympathy; the blow that brings tears to our eyes when it lights upon a friend brings only smiles when it falls upon an enemy. Two vessels are opposite our shore. They are laden with men suffering from the most loathsome disease, and yet not a line of compassion is written. Two vessels crowded with suffering humanity—foul, impure, abominable humanity, if you will, but still humanity. And yet not a word of pity is heard. We are, it is needless to say, opposed to the Chinese—bitterly, irrevocably opposed. But these men have come to California—as under the existing law they had a right to do—and our honor demands that we should not see them suffer needlessly; our honor demands that not another single ache should be laid to our account. Think of the torture and despair of those condemned to live in the midst of contagion and forbidden to fly from infection.

Picture the loathsomeness of the dark holds of the ship. Think of the aching heart and limb. Their head throbs as wildly as ours; the blood burns as fiercely in Mongolian as in Caucasian veins. If we do not respect these men, in heaven's name let us respect their misery. For the sake of humanity, for the sake of the honor of white men, let something be done, and be done quickly. Let a place be found. Let the undefiled be separated from the plague-stricken. Let them be placed where everything they touch may not convey to them disease and pain and agony; where every breath they breathe may not come to them laden with the seeds of death.

SAN FRANCISCO, CAL., *July* 15, 1882.

Hon. CHAS. J. FOLGER,
Secretary of the Treasury, Washington, D.C.:

SIR: In obedience to orders issued by direction of the President upon the request of the National Board of Health, through the War, Navy, and Treasury Departments, we, viz, Col. Charles Sutherland, surgeon, United States Army; John Van Sant, surgeon, United States Marine Hospital Service; G. W. Woods, surgeon, United States Navy, assembled as a commission, on the 5th instant, at the custom-house, San Francisco, Cal., to investigate the existing quarantine regulations at the port of San Francisco, as affecting the introduction of contagious and infectious diseases, with a view to determining what changes may be necessary, if any, for the protection of the public health, and also to consider the recommendation of a suitable site for the establishment of a national quarantine station, should such station be deemed necessary.

The commission was then organized by the selection of Col. Charles Sutherland, surgeon, United States Army, as chairman, and Surgeon G. W. Woods, United States Navy, as secretary.

After numerous sessions, a careful inquiry into the matters appertaining to the subject before the commission, and an inspection of the harbor with a view to the selection of a proper quarantine site, we beg leave to report as follows:

1st. The actual condition of the quarantine arrangements at the port of San Francisco.

The quarantine is established by State law, and enforced through the local board of health created by the same enactment. We find the regulations to be ample, and in accordance with the principles governing quarantine in the other great ports of our seaboard States. A compliance with all these regulations is, however, prevented by the lack of appropriations, and attention is especially called to Section 3022 of the "Quarantine Regulations for the Port of San Francisco," providing for the erection and equipment of suitable hospitals, which, according to the statements of the health officer, J. L. Meares, M. D., and other members of the board of health confirm the statement—is necessarily of no force, as there is no available fund for carrying out its provisions. Under these circumstances it has been the custom to transfer the sick of infected ships to the local hospitals under the control of the board of health, the passengers and crew being removed to steamers, or hulks, within the harbor, there to spend the period of incubation; all expenses to be borne by the consignees.

2d. To determine what may be necessary to protect the public health, and to prevent the importation of contagious and infectious diseases.

The following arrangements are deemed a necessity at this port, viz: A proper quarantine establishment, floating or on shore, embracing the following divisions. If on shore, (1) a boarding station distinct from the quarantine grounds proper; (2) hospital for the sick with the usual attendants; (3) building for the detention and entertainment of the well; (4) building for the reception and disinfection of cargo, baggage, and personal apparel.

If a floating quarantine, three hulks could be devoted severally to the same purposes. The quarantine regulations of the Atlantic ports are framed to control four diseases, viz, small-pox, typhus or ship-fever, yellow-fever, and cholera. On the Pacific coast it seems to be practically reduced to the control of small-pox, especially present on the steamers and sailing vessels engaged in the transportation of passengers from the ports of China. Cholera may, however, find its way here by the same route from its original Asiatic source, through vessels in the Chinese and Japanese trade, and both this disease and yellow-fever have been imported on vessels coming from the Isthmus of Panama. Therefore, the quarantine regulations of this port must embrace these diseases in their list, and the same preventive measures be employed as in eastern cities.

In reference to vessels from Asiatic ports, we would recommend that the "Act to prevent the introduction of contagious and infectious diseases into the United States," approved June 2, 1879, be rigidly enforced, particularly as regards section 2, in reference to Chinese ports, and that our consuls be instructed not to issue "bills of health" until an honest medical examination has been made of the vessel and her passengers.

3d. The consideration of a suitable site for a national quarantine station, should such a quarantine station be deemed necessary.

The commission deems a quarantine station, such as has been briefly described, a necessity at this port, and with a view to the determination of an appropriate site, have made a careful inspection of the harbor on board the revenue-cutter Richard Rush.

The following points were carefully examined, and their merits or defects are here noted.

(1.) *Point Diablo.*—Shores too precipitous, requiring expensive excavation. Too near the Golden Gate so as to feel the influences of the open sea, and exposed to the southeast winter storms.

(2.) *Lime Point.*—Shore well adapted to the erection of buildings. Cove not capacious

enough for the purposes of quarantine. Large vessels would have to anchor in the stream. Exposed to southeast storms.

(3.) *Saucelito and its vicinity.*—A good position, but being the site of a town and railroad terminus, as well as Yacht Club headquarters, available positions for the erection of buildings could not be obtained without much strife, and a floating quarantine would be equally objected to.

(4.) *Richardson's Bay.*—Insufficient depth of water.

(5.) *Cove immediately to the north of Peninsula Point, between Peninsula Point and Tiberon Point, in Raccoon Straits.*—An admirable sheltered position, out of the influences of the ebb-tide, and good depth of water up to within such a distance of the shore as to render the building of wharves an easy task. Land adapted to the erection of buildings without expensive earthworks. Cove sufficiently protected from weather influences at all seasons of the year.

(6.) *Tiberon Point.*—Objected to as not having a sufficiently capacious anchorage for vessels so as to escape the strong tide influences of the open straits. To the northward of the point the objection would be that it is directly in the line of travel to San Rafael.

(7.) *Angel Island.*—Four points were examined: 1st. Hospital Cove, in Raccoon Straits; not of sufficient capacity. 2d. Northeast point of island; too precipitous. 3d. Waterman's Bay; same objection. 4th. Southeast point of island; complete exposure to all winds renders this point particularly objectionable. The three last-mentioned places are also objectionable as being on one of the principal lines of interior steamer travel.

(8.) *Goat Island.*—On its northern shore is an extensive shoal. Its eastern shore and harbor is occupied for military and light-house purposes, while its southern and western shores, beside being too precipitous, are not available, being in the line of ferry travel to Oakland.

In selecting a site for a quarantine station it is important, on account of the continuous foggy weather of our summer months, to select a position outside of our thoroughfares for steamboat travel and harbor entrance. This can only be found in Raccoon Straits, a water-way between Angel Island and the mainland of Maria County, through which there is but little travel beyond that of the Italian and Chinese fishermen. These straits are also protected to a great degree by the influence of the local "trade winds" and winter storms.

No. 5 (the cove to the north of Peninsula Point) is, therefore, agreed upon as the most available place within the waters of San Francisco Bay for a quarantine station, presenting the following advantages, viz: Accessibility, good anchorage, out of the influence of the strong ebb-tides, protection from prevailing winds, facilities for the erection of buildings without expensive grading, non-interference with steamers on regular routes of travel. And we recommend this site for the establishment of a quarantine station, whether it be national, State, or municipal.

Fourthly. Are the existing quarantine arrangements of the city of San Francisco sufficient and properly managed?

The commission deems the regulations to be sufficient; but, according to the statements of J. L. Mears, M. D., executive officer of the board of health, and other members of that board, being denied the means of carrying them out in the most efficient manner, the arrangements are deemed inefficient and not in accordance with the usage of our larger commercial ports, where the annoyances of quarantine, to both travel and commerce, are reduced to a minimum; and no quarantine can be efficient which is not prepared for emergencies, with the necessary means for carrying out its regulations with all the speed, comfort, and convenience consistent with safety to the public health.

Extracts from a communication received from Henry Gibbons, jr., M. D., a member of the board of health, to which the concurrence of J. L. Meares, M. D., executive officer of the board of health, is appended, marked A.

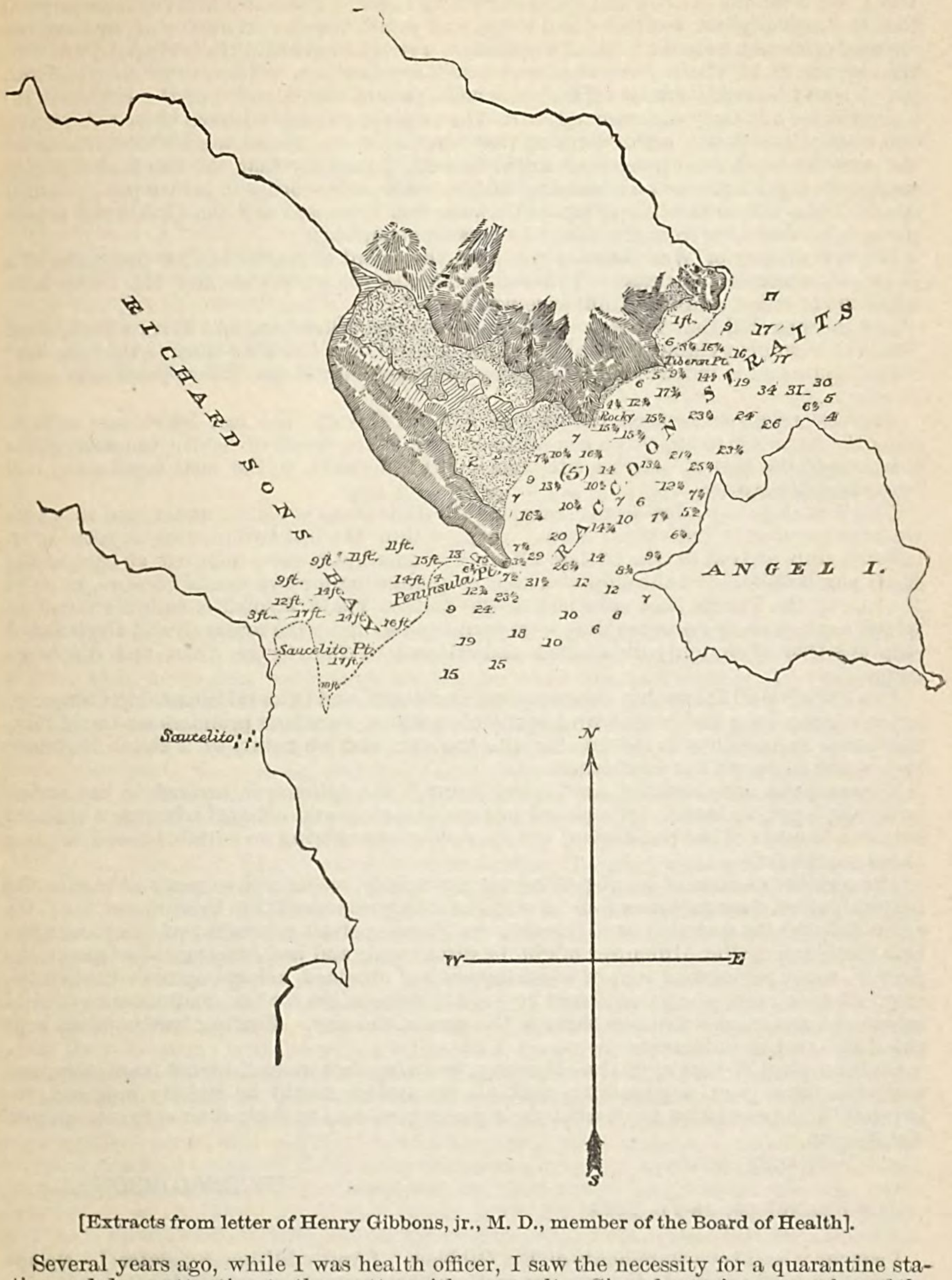
This communication explains some of the workings of the present quarantine system, illustrated by recent events, gives some of the history connected with efforts to select a quarantine station, and refers to a present movement on the part of the State board of health to the same end. A statement, in rejoinder, from the consignees of the Altonower, is associated with this abstract.

The commission having completed its labors, adjourned July 15, 1882.

We are, respectfully, &c.,

C. SUTHERLAND,
Surgeon United States Army.
JNO. VAN SANT,
Surgeon United States Marine-Hospital Service.
G. W. WOOD,
Surgeon United States Navy.

APPENDIX V.



[Extracts from letter of Henry Gibbons, jr., M. D., member of the Board of Health].

Several years ago, while I was health officer, I saw the necessity for a quarantine station and drew attention to the matter with no result. Since becoming a member of the board of health, this board has earnestly sought to secure a location. Two years since, we secured the co-operation of Hon. Horace Davis, our representative, in an endeavor to obtain from Government some island, or part thereof in the harbor for our uses. Through the State board of health, we communicated with the National Board, and obtained its assistance. The General Government made inquiry of its military officers here and appointed a committee, Colonels Mendel and Stewart, to report if there was any available site for quarantine purposes.

General McDowell strongly objected to Angel island, and recommended part of Goat island or Lime point, or Kersham's island. The engineers objected to our having Lime

point or Goat island, as they were required for the defenses of the harbor, and upon inspection of Kersham's island, in company with the colonels above-named, and Hon. H. Davis, we went out in a tug and spent some time there. The board and engineers argued that it was ineligible, too rocky and steep, and would require an outlay of an immense amount of money to make it at all available. I should have said that originally our own inquiry was as to whether we could secure the southeastern extremity of Angel island, which could be easily fenced off from the main part of the island, but the engineers required it for a battery to command, with Alcatraz, the passage between these two points; and finally, it was our understanding that the engineers named would recommend for our uses the northeastern angle of Angel island. I may say that the San Rafael people were very much exercised on learning that we were endeavoring to secure part of Angel island, since it is in the line of travel between San Francisco and San Rafael and small-pox might blow over from the island to passing steamboats.

When Secretary of War Ramsay was here the board of health called upon him in a body and presented our case. You will remember that both he and Mr. Davis soon went out of office, and their influence was lost.

It was suggested that Tiberon point would be a good location, and that as the United States Government claims it it might be set aside for us. But we learned that the land is in dispute and is indeed held by settlers, and years may elapse before possession could be given.

As a last resort we secured the passage of a bill through the last legislature authorizing the governor to appoint a committee of the State board of health to examine the locations in the harbor, select a site, and report the result to the next legislature, and here the matter rests.

Now I wish to say a few words regarding the difficulties we labor under, and the plans we have pursued in individual cases. Until within the last two months, as soon as an infected ship arrived in the harbor, all cases of small-pox were removed at once to the small-pox hospital, and the ship was kept in quarantine for two weeks or more, or as in the case of the Pacific Mail steamers, if the owners could furnish a suitable vessel on which to place the passengers they were permitted to make the removal, and the infected ship was then thoroughly disinfected and allowed to come to the wharf and discharge cargo.

The Pacific Mail Steamship Company and Occidental and Oriental Steamship Company, being regular lines and owned by responsible parties, on whose promises we could rely, there was no hesitancy in permitting the transfer, and we never, in a single instance, had reason to regret our confidence.

Two months ago, however, an "ocean tramp," the Altonower, arrived in the harbor with small-pox on board. We placed her in quarantine and debated whether we should permit a transfer of her passengers, but the consignees offering no suitable vessel to place them on, we refused.

The number of cases of small-pox increasing rapidly, we refused to receive them in the hospital unless their expenses were paid. The consignees acceded to this proposition. We again debated the question as to whether we should permit a transfer of the passengers that the cargo of the Altonower might be discharged, and had determined to grant the permit, when we learned that the consignees had obtained a legal opinion that in the event of a transfer they would not be legally responsible for the maintenance of said passengers and might abandon them to the care of the city. Fearing treachery we kept the Altonower in quarantine.

On the arrival of the Belgic the other day, knowing that we could trust its owners, and receiving from them a guarantee that all our orders would be strictly enforced, we granted them permission to transfer their passengers, and to dock their ship after proper disinfection.

Very truly, yours,

HENRY GIBBONS, JR.

SAN FRANCISCO, *July* 5, 1882.

I concur with above statements of Dr. Gibbons. [And additionally states:] No appropriation has been made to carry out section 3022, quarantine regulations.

J. L. MEARES, M. D.,
Health Officer.

A true copy.

G. W. WOOD,
United States Navy, Secretary to Commission.

SAN FRANCISCO, *July* 15, 1882.

Dr. GEO. W. WOODS, *U. S. N.*,
Mare Island Navy-Yard, Mare Island, Cal.:

DEAR SIR: As you have stated to us that you have been informed by the board of health of this city that our legal advisers informed us that should the board of health allow the passengers of the steamship Altonower to be transferred to a hulk, the city would become responsible for their maintenance and support after such transfer, we beg to state that we never received any such opinion from our attorneys, but, on the contrary, we repeatedly assured the said board of our willingness to take upon ourselves whatever expense or responsibility might arise from such transfer, and we further employed our attorney, Mr. Hall McAllister, of the firm of McAllister & Bergin, to appear before the board and convince them that our bond would fully relieve the city from all such expense or liability, to which argument the board made no reply, and apparently paid no attention whatever. We claim that the hulk provided by us was in every way most fit for the accommodation of the Chinese passengers upon the above steamer, and we must beg to submit our positive opinion that the board of health acted in a most negligent manner with respect to this business, catering rather to the local popular prejudice than to the commercial interests of the port.

We remain, dear sir, your obedient servants,

MACONDRAY & CO.,
Agents Steamship Altonower.

A true copy.

G. W. WOODS,
Surgeon, United States Navy, Secretary of Commission.

Hon. J. L. CABELL,
President National Board of Health, Washington, D. C.:

SIR: In reply to yours making inquiry respecting quarantine affairs at this port, and inclosing copies of an order of the National Board of Health and letter from the Chinese consul, with newspaper comments, we beg leave to inclose a copy of our quarantine laws, and state the practice followed in carrying them into effect.

When a vessel arrives with no disease of a contagious character we permit her to proceed to the wharf immediately, the only exception to this has been steamers plying between this port, Hong-Kong, and Yokohama, which are detained in quarantine long enough to vaccinate the passengers and fumigate the vessel. When the passengers are properly vaccinated by the ship's surgeon during the voyage even this detention is not exacted.

In April, 1880, this board passed an order that all Chinese passengers should be vaccinated before being permitted to land. The necessity for such an order arose from their dread of vaccination rendering it impossible after they once got ashore, in fact our experience taught us that the almost continual prevalence of small-pox in this city was largely due to the presence of so many thousands of unvaccinated Chinese in our midst; since the above date, therefore, every passenger is detained on board the ship on which he arrives until he submits to be vaccinated. Had this passenger traffic remained with the regular steamship lines, whose vessels were constructed for carrying passengers, and, when their steamers were placed in quarantine, furnished another ship with equal accommodations, to which those exposed to the disease were transferred, the occasion for such exaggerated and partial statements as these made by the Chinese consul regarding the Altonower would not have arisen. Unfortunately the immense hordes of Chinese desiring to come to this country, some 30,000 this year, brought into the passenger-carrying business a class of British steamers never intended for such traffic, constructed only for freight, without any convenience for cleanliness, carrying no surgeon, overcrowded so as to violate the United States laws; filthy beyond description, they presented on their arrival in this port an appearance much more resembling the slave-ships of former times than a passenger steamer of the present day.

To this class belonged the Altonower, the cause of Consul Bee's communication, arriving here from Hong-Kong with 874 Chinese passengers.

Upon proceeding to fumigate the hold, the quarantine officer discovered a Chinaman with variola in the eighth day of the eruption. This man was immediately removed to the hospital on shore, all on board vaccinated, and each succeeding case as it was developed, transferred to the hospital until over twenty had been so placed; it then occurred to the authorities of this city that the expense of supporting and attending an unlimited number of Chinese coolies suffering from variola *should by right be borne by those bringing them here*. They therefore refused to take charge of any more unless the ship paid for them. After a delay of some days the consignees of the Altonower agreed to do so, when

all infected were removed to the hospital as the disease developed, numbering some eighty-four in all. The remaining passengers on the Altonower who had been exposed to the disease would have been transferred to another vessel suitable to accommodate *them had such been offered.*

The old ferry-boat proposed for that purpose we considered entirely unsuitable, as well as unsafe, liable to capsize if a storm occurred on the bay, and we did not desire to assume the responsibility of endangering their lives for the purpose of releasing the ship and satisfying the representative of the Imperial Government of China. Having no accommodations on shore, and no safe vessel to transfer them to, they remained on board the Altonower until the period of incubation had passed after the development of the last case, when the ship was released from quarantine.

With regard to the comments of such newspapers as the Beacon (Berkeley) and the Argus (Petaluma), it requires little strain of the imagination to discover the source of their "merciful appeal"; we do know that there are two villages in this vicinity with the above names which "mercifully" send their sick poor to the hospital of this city for treatment at our expense. Never having before heard of the existence of the newspapers referred to, we may be pardoned for thinking that the copy received by your honorable board may have exhausted the edition.

Finally as to our present means of preventing the introduction of contagious or infectious diseases and the need of a quarantine station.

San Francisco has no quarantine establishment, no facilities of any kind for purifying and disinfecting immigrants arriving with contagious or infectious diseases; a small steam launch and the quarantine officer comprise everything at the disposal of the health authorities for such purposes. The geographical position of San Francisco causes it to receive all the emigration from the different nationalities of Asia coming to the United States and intercept any disease they may bring. The especial character of this immigration, chiefly Chinese coolies, having no regard to sanitary laws, and bringing with them diseases of a most contagious character, render it absolutely necessary that this port should possess a quarantine station commensurate with the important position it occupies in guarding against the introduction of such diseases as small-pox and Asiatic cholera into the United States.

This board has persistently for years urged upon the authorities of our own State and the United States the necessity of some action in this matter. Two years ago our representative in Congress, the Hon. Horace Davis, called the attention of Congress and the United States Government to our lack of quarantine facilities.

The president of our State board of health, Dr. Henry Gibbons, solicited the assistance of the National Board of Health, and Dr. Billings promised to aid us with all the power possessed by the board.

The Hon. H. Ramsey, Secretary of War, when here in 1880, had pointed out to him our condition, and was requested to grant us a small piece of land from one of the many suitable places in our harbor belonging to the United States.

To avoid detail we may refer you to the records in Washington for information regarding the efforts made, all of which for reasons unknown to us were unsuccessful, and we had about concluded further appeals were useless when we received your communication and feel thankful that the Chinese consul has succeeded in arousing, which *we failed* to do, the attention of the health authorities of the United States to the importance and necessity for a quarantine station at this port. Further, we assure you that we will most heartily co-operate with any commission appointed to report upon this subject, and give them all the assistance and information in our power.

Very respectfully,

JAS. SIMPSON, M. D.,
HENRY GIBBONS, M. D.,
W. ANDREW DOUGLASS, M. D.,
Committee of the Board of Health of San Francisco.

SAN FRANCISCO, CAL., *July* 25, 1882.

APPENDIX O.

SECOND REPORT ON THE RESULTS OF AN INVESTIGATION INTO THE FILTERING CAPACITY OF SOILS.

By Raphael Pumpelly,

Assisted by Dr. George A. Smyth.

Newport, R. I., *November* 3, 1883.

My Dear Sir: In 1880, at my request, the National Board of Health intrusted to my charge a series of investigations into the capacity of soils in filtering the low forms of life out of ground-water and ground-air; and it appropriated therefor the money necessary for the pay of an assistant, and for laboratory expenses.

I engaged as assistant Dr. George A. Smyth, who executed the entire laboratory work, and whose contribution to the investigation consisted in skillful and delicate manipulation and in valuable suggestions.

Whatever success has attended our work has been largely due to Dr. Smyth's skillful manipulation.

In March, 1881, I submitted a report (Supplement No. 13, National Board of Health Bulletin) showing the condition of the work at that time.

Owing to the action of Congress, the work was suddenly stopped in the summer of 1882, and the laboratory was broken up and my assistant discharged before we had finished the preliminary investigation which was to prepare the way for the experiments on ground-air and ground-water in different soils.

As Dr. Smyth, who kept the record of the investigation, did not find it practicable to take the time necessary to tabulate the work, this labor, involving the tabulation and condensation of a vast mass of material in records and cross-records, was kindly undertaken by others. It has been impossible to complete this early enough to give the time necessary for a full discussion of the results. I have only attempted to draw the most general inferences, leaving the fuller discussion to another occasion.

It is impossible that some errors should not have occurred in the arrangement of a mass of material without the aid of the keeper of the record. The arrangement was rendered more difficult by the fact that during the last year of the work I was not in the laboratory, nor did I see the record, nor give any personal attention to the different series of experiments further than what was needed to decide upon their being started, and the method.

Since the time, unfortunately, does not permit the rearragement and final discussion of the whole work, I must refer to the former report for the details of the beginning of the experiments, and for the description of the methods. With the present tabular statement of the later work I have included all of the former tables, as many of them contained experiments still incomplete at the date of the previous report.

It seems also desirable to repeat here the summary, which I gave in a former report, and to follow it with the summarized statement of the later results.

Very respectfully, your obedient servant,

RAPHAEL PUMPELLY.

The President of the National Board of Health,
Washington, D. C.

SUMMARY OF THE FORMER REPORT.

[Repeated from Supplement No. 13.]

Thus far the work has been confined to the soils and some other substances as filters in eliminating living low vegetal organisms from air and fluids, and in this direction we have only made a beginning.

The great practical importance of this part of the subject led to its being considered first. The weight of authority among students in sanitary science is in favor of recognizing some genetic relation between the lower vegetal organisms and the epidemic prevalence of certain diseases. It is known that these low forms of life are capable of being carried in fluids and of floating in the air where, owing to their almost infinitesimal lightness, they are buoyed up by the slightest currents.

It has long been known that certain soils in time lose their ability to filter out the impurities from polluted waters. Many cases of disease are supposed to have been traced directly to the use of water containing sewage that had passed for a greater or less distance through the soil.

Again, it is an established fact that the air with which the soils are permeated above the surface of the ground-water vibrates to every barometric change in the outer atmosphere; that it moves in currents caused by this sympathy and by thermometric differences. And Pettenkofer and others have called attention to the importance of these currents of ground-air from a sanitary point of view.

When we consider that every vault, cesspool, and cemetery is a center of pollution to the ground-water which supplies our wells, and to a certain extent, also, the reservoirs for cities, we can appreciate the importance of ascertaining to what extent soils are capable of eliminating the injurious properties contributed by the pollution.

Through the cellars our houses become, especially in winter, the ventilating chimneys for the surrounding ground, sucking in from all directions the air that has been nearly stagnant in the pores of the soil during the summer. In view of the fact that the ground-air is polluted by vaults, cesspools, and cemeteries in the country, and by the garbage of made ground and defective drains and sewers in cities, it is important that we should determine the extent to which different soils are able to filter the injurious properties out of the air passing through them.

In working toward the solution of these problems, our apparatus has consisted essentially of two parts:

1. The substance to be tested as a filter.
2. An infusion of beef, or some other easily putrescible substance.

FIG. 1.

In the simplest form this consists of a tube with a neck (*a*), on which rests a copper gauze (*b*) supporting the substance to be tested (*c*); the lower end of the tube contains the infusion (*d*). The whole apparatus is heated sufficiently to insure the destruction of any germs or adult bacteria. Similar infusions exposed in open capsules unprotected to the air invariably showed signs of putrefaction within forty-eight hours. Such exposures accompanied all of our experiments as control tests.

The experiments conducted thus far fall readily into four classes.

I. DRY FILTERS FOR AIR.—The sterilized infusion was protected from the germs of putrefaction that float in the air only by the column (1 millimeter to 17 centimeters high) of the substance to be tested.

In this series there were nearly ninety filters tried of asbestus, sand, loess, charcoal, animal charcoal, and coal ashes. After standing three to eight months, omitting four defective and one doubtful case, the infusions used are *all* sound, excepting where the filter was coarse sand (10°–20°, *i. e.*, 10 to 20 grains to a linear inch), or animal charcoal that would just pass through a sieve of 15 meshes to the linear inch.

II. WET FILTERS FOR AIR.—These differed from the first only in having the filters saturated with sterilized water. The same materials, except coal ashes, were used as for the dry filters, and, disregarding one doubtful and five defective cases, all have proved perfect protectors to the infusion beneath them, except two filters of coarse animal charcoal (15°), and one of loosely-packed asbestus, which failed to protect the infusions, perhaps owing to absorption of the water and conversion into dry filters.

III. QUANTITATIVE EXPERIMENTS FOR AIR WITH DRY FILTERS OF SAND, ASBESTUS, AND ANIMAL AND VEGETABLE CHARCOAL.—Fig. 2 shows the apparatus employed.

In these experiments an artificial current was produced, the air being sucked by an aspirator connected at *f* (see Fig. 2) through the filter (*c*) and into the infusion (*d*).

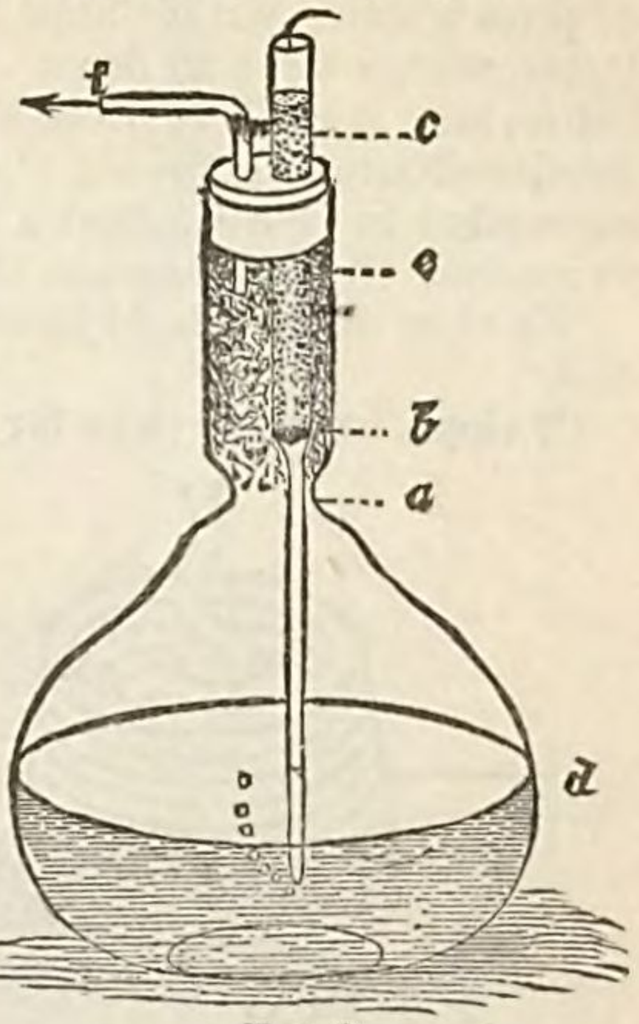


FIG. 2.

In one set of these experiments the air was passed through in a slow current—1 to 6 liters in 24 hours. These experiments were started at different dates between June 19 and October 30, and subjected to continuous currents. One filter, loosely-packed asbestus, 5 centimeters high, has failed after passing 89 liters of air. It will be seen from the tables that the others are still fresh (February 10) after passing 180 to 434 liters.

In another set the filters were subjected at intervals during five months to rapid currents, beginning at the rate of 1 liter in 4 to 7½ hours and increasing to 1 liter in 1½ minutes. These filters (Fig. 3) consisted of columns (*c e*), 10 centimeters high, of sand, 30° to 50°—*i. e.*, screened through 30 to 50 meshes per inch.

Sand, 100°.

Asbestus packed rather tightly.

All the filters have stood this extremely trying test, the infusions remaining intact.

These experiments go to show that as long as the grains are small all the substances tested filter perfectly all organisms from the air passing through them.

IV. EXPERIMENTS IN FILTERING BACTERIA AND THEIR GERMS FROM LIQUIDS.—In these experiments there were tried (see Fig. 1) three sets of filtrations, the liquids being respectively:

a. Fresh infusions.

b. Putrid infusions.

c. Water.

In the first set the filters employed were sand, charcoal, and animal charcoal, the finest of each being 100°, and asbestus in columns of 15 centimeters. All failed to filter out the germs except two filters out of twelve of asbestus, and the finest animal charcoal; the remaining asbestus and coarser animal charcoal (15°) and vegetable charcoal in all grades failing equally with the sand.

Similar filters were used in the second set (filtration of putrid infusions), except that of charcoal filters nothing finer was used than vegetable 25° to 50° and animal of 15°.

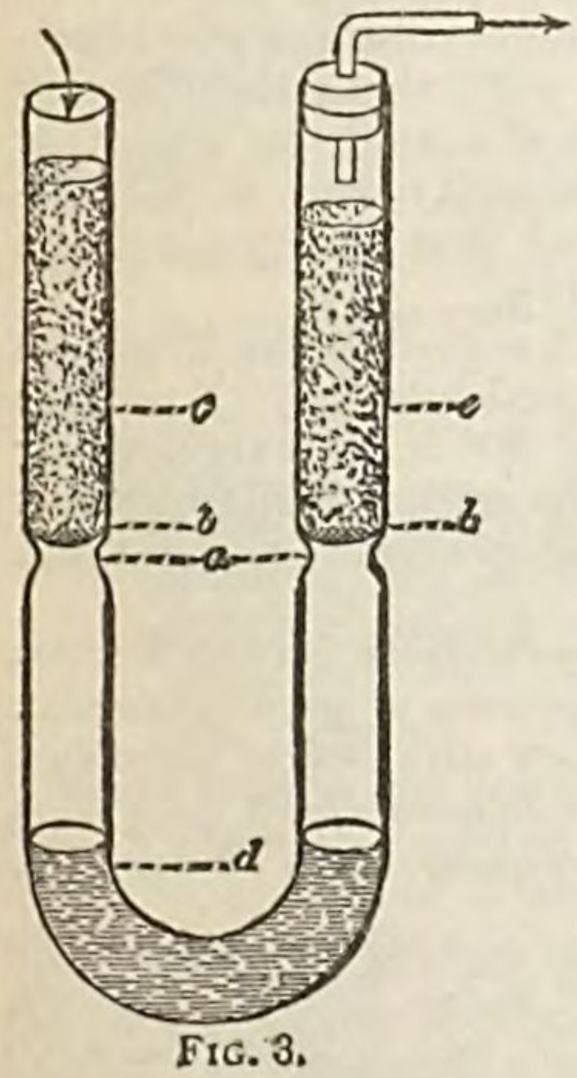


FIG. 3.

In this set only tightly packed asbestus stood the test; in all the others the infusion passed through turbid.

But it will be noticed that in the previous set the finest animal charcoal filtered perfectly an infusion that became putrid during the process.

In the third set (filtration of water) the substances tested were columns 15 centimeters high of:

Asbestus, tightly packed.

Charcoal, 25° to 50°, and others of 100°.

Animal charcoal, 15°, and others, 100°.

Loess from near Council Bluffs, Iowa (taken 40 feet below the surface).

Kaolin.

One part kaolin, three parts sand.

One kaolin, one sand.

Coal ashes, 10° to 100°.

Sand, 25° to 30°, 30° to 50°, and 100°.

The experiments were conducted so that only a drop or two of water should reach the infusion at first; more water being passed after intervals of several days, where the infusion remained uninfected.

Of these the tightly packed asbestus stood repeated filtrations during 10 days, after which the infusion putrefied.

Of the finest animal charcoal filters one out of four filtered out the germs.

The other three stood repeated filterings during 17 to 20 days, after which the infusion became infected.

The coal ashes were subjected to repeated filtrations during 10 to 19 days, after which the infusions putrefied.

The infusion under the loess filters broke down after from 6 to 8 days.

Those under the kaolin and the mixtures of kaolin and sand all broke down after from 1 to 8 days (although only a few drops had passed in each case), excepting one out of six of pure kaolin, which kept for 19 days, and one out of six of kaolin and sand, in equal parts, which kept 20 days. In all others, the first drop that passed through infected the infusion. And it is probable that in the repeated filtrations, except in the one case of the finest animal charcoal, there was either a differential filtration, or that only so few germs succeeded in passing that a much longer time than usual was required for the infusion to assume the opalescence that betrays infection.

We now made a bold jump from columns of 15 centimeters to columns of 22 and 100 feet.

Of these we have thus far tried only sand of mixed grain 18° to 100°.

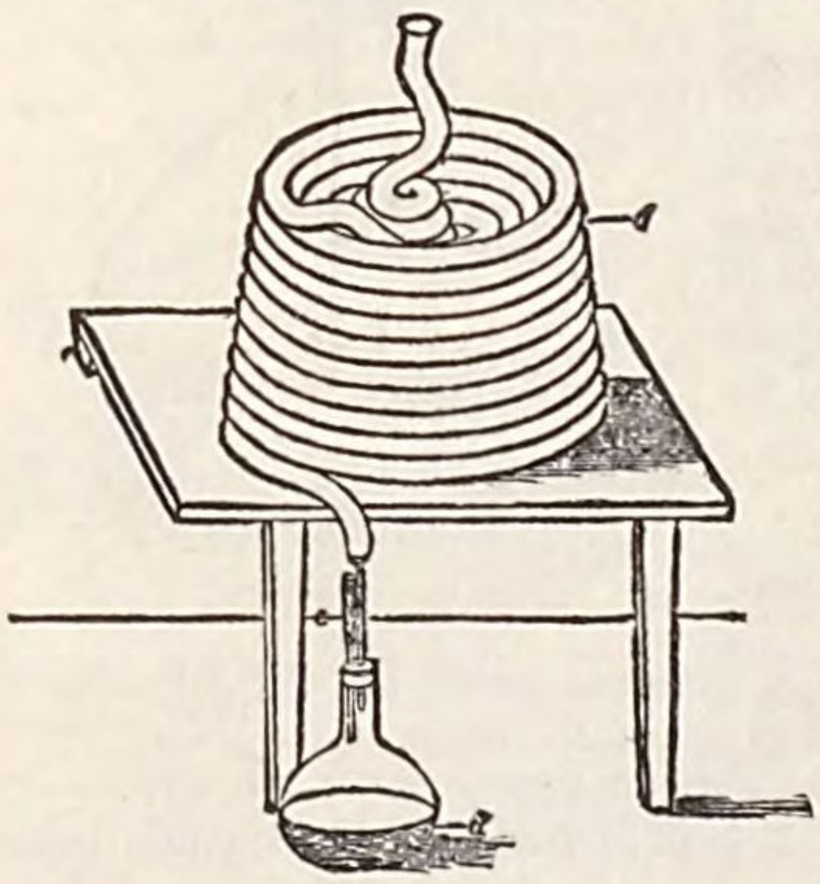


FIG. 4.

To obtain sterilized columns of such a length the sand was intensely heated and poured into a lead pipe (*c*) (Fig. 4), which was then coiled. It was then placed in a furnace and heated to between 250° and 300° C., and then the lower end attached to the flask containing the infusion (*d*), and ventilated through a tube protected by sterilized asbestus (*e*).

The whole was then allowed to rest several weeks to be sure that the infusion had been properly sterilized. The pipe was then very slowly filled with tap-water. *The first water that passed through each of the* 22 *and* 100 *foot columns carried infection with it.*

Although our experiments have thus far been more of a tentative character, and preliminary to quantitative work, they permit us to draw a few sharply-defined conclusions:

I. All the substances operated on are excellent filters in eliminating germs from *infected air* passed through them, except when they are of a coarse grain 10° to 20°, when the interstitial cavities become probably much less labyrinthine. And all these filters withstood the test of currents having many thousand times the maximum velocity attained in the soil.

II. All natural substances tried thus far, except the finest animal charcoal, and perhaps tightly-packed asbestus, failed to eliminate wholly the germs from liquids.

In the only natural soils tried, the sand, loess, and kaolin, we find in the sand an absolute absence of filtering power as regards germs in water, which would probably be as evident in columns of 10,000 feet as of 100 feet. In the loess, and in the much more compact kaolin, on the other hand, there is evidence of a greater filtering power. In these cases it is not unlikely that we shall find that somewhat longer columns will eliminate the germs from the first water passing through; and that with them the filtering capacity is merely a question of the relation of length of column to amount of water.

At this point in our work it seems as though the filtering capacity were wholly dependent on the size and intricacy of the interstitial cavities; and that in dry-air filters there is a critical limiting point beyond which there is no filtering.

And the same remarks seem to be true in different degrees with regard to the filtration of liquids. Here far greater fineness and compactness of grain and intricacy of passage are needed than are requisite for air filtration. While sand of 20° is an excellent air filter, sand of 100° in long columns is worthless for water, and the critical limiting point below which soils begin to exercise any filtering action probably verges on the size of grain in an impalpable powder.

From these results it appears very clearly that sand interposes absolutely no barrier between wells and the bacterial infection from cesspools, cemeteries, &c., lying even at great distances, in the lower wet stratum of sand. And it appears probable that a DRY GRAVEL *or possibly a* DRY VERY COARSE SAND *interposes no barrier to the free entrance into houses built upon them of these organisms which swarm in the ground-air around leaching cesspools, leaky drains, &c., or in the filthy made-ground of cities.*

And from the results obtained from the two series of experiments, viz, in filtering air and in filtering water, we can now draw one very important practical conclusion which can not be too strongly emphasized: *That a house may be built on a thoroughly dry body of sand or gravel, and its cellar may be far above the level of the ground-water at all times, and it may yet be in danger of having the air of its rooms contaminated by the germs from leaching cesspools and vaults; for, if the drift of the leaching be toward the cellar, very wet seasons may extend the polluted moisture to the cellar walls, whence, after evaporation, the germs will pass into the atmospheric circulation of the house.*

We are, however, only at the beginning of the subject. Our next studies will be in part the determination of influence of size of grains and character of interstitial passage;

the influence upon the germs of length of time occupied in transit; of temperature and pressure, and of presence or absence of nourishment in the liquid. And all of our experiments will be extended to the different soils and to some porous rocks. We are also about to determine the presence or absence of germs at various depths in different soils.

The important question now in controversy regarding the ability of germs or bacteria or other particulate matter to disentangle themselves from a liquid and become suspended in the atmosphere has an important bearing upon the relation between ground-water and ground-air.

For this reason we have carried on several series of experiments in this connection.

Referring to the full description of the methods and apparatus for details, I will give here only a general outline, with the results:

I. In the first series (see Fig. 5) water, sewage, and putrefied substances (f) were suspended in flasks over a sterilized beef infusion (d) in a room where the temperature ranged between 20° and 35° C. At the end of 80 days the infusions were intact.

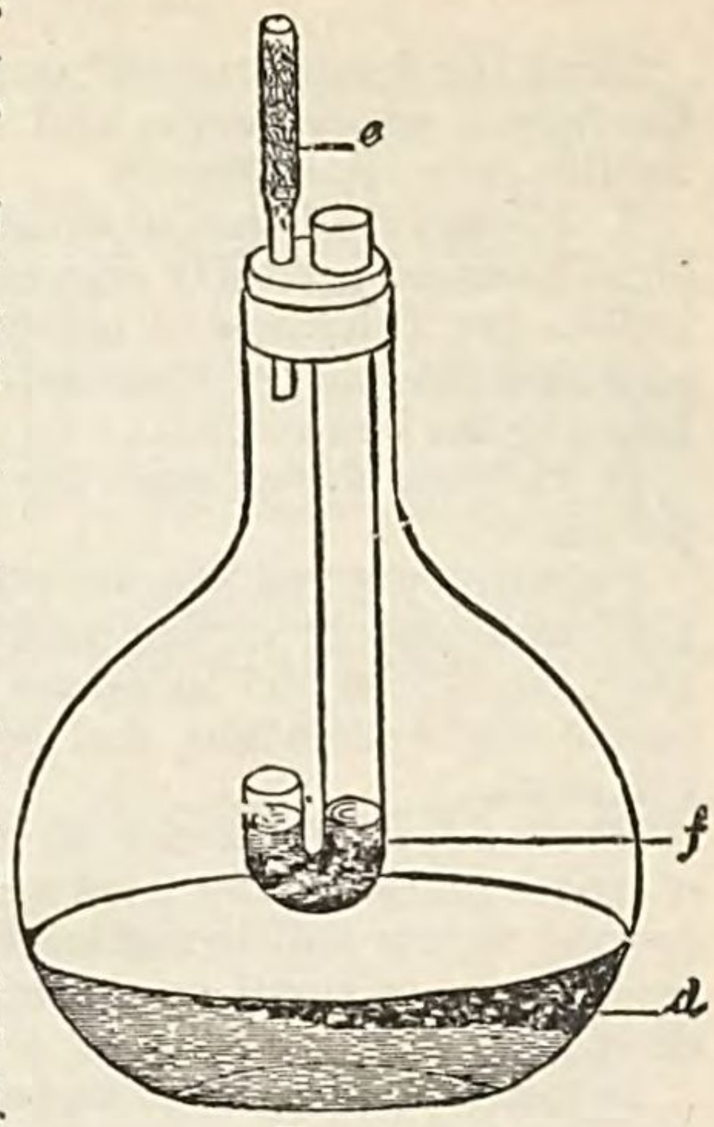


FIG. 5.

After the furnace fire was started in the autumn the heat from the register, which was below the flasks, seems to have caused the transmission of the infection from the water and putrid infusions to the infusion in three out of five flasks, while the remaining two are still intact after five and six months, respectively, although repeatedly exposed to temperatures of 37° to nearly 42° C.

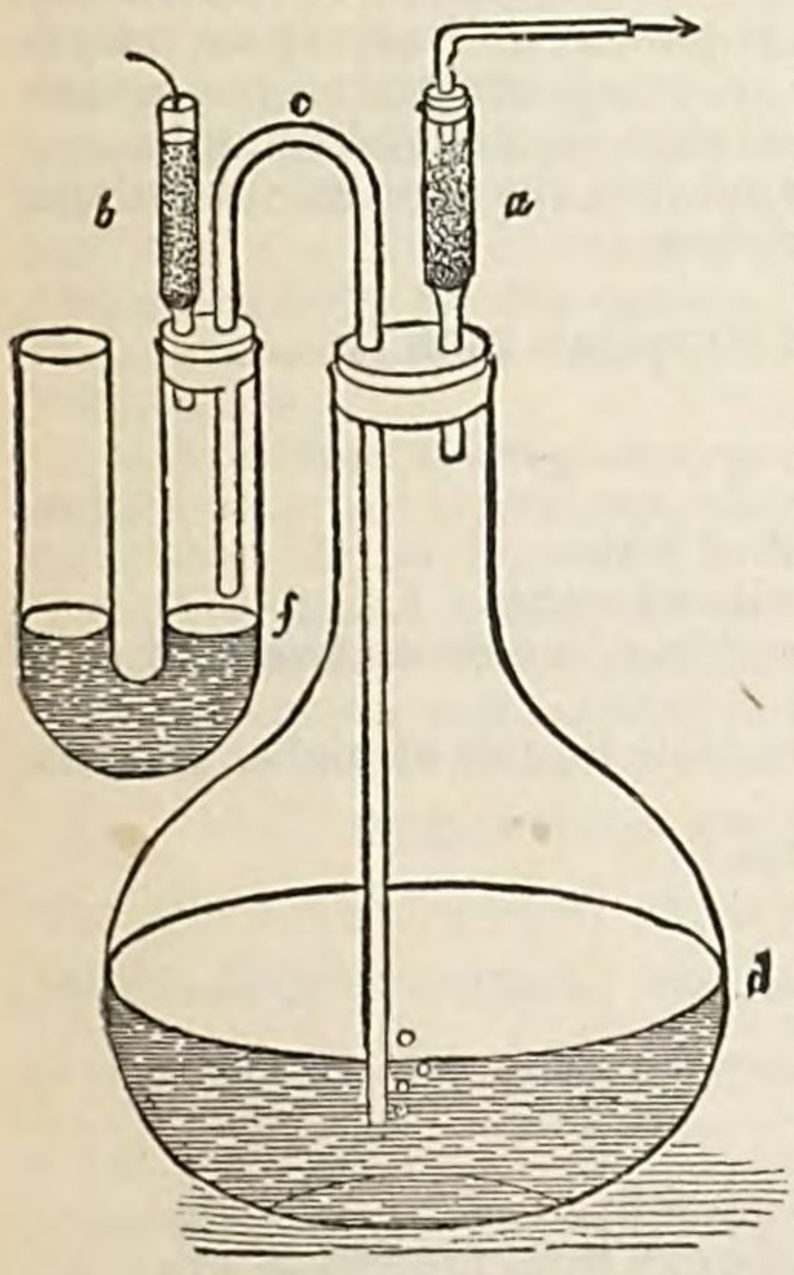


FIG. 6.

II. In another series (see Fig. 6) of three flasks, during more than a month, air filtered through asbestus (b) was aspirated from immediately above the surface of the infected fluid (f) and made to pass through the infusion (d) at the rate of $3\frac{1}{2}$ liters per day. In all three flasks, after nearly six months, the infusion is still intact.

III. A third series was instituted to determine the possibility, suggested by Colonel Waring, of germs becoming liberated from the liquid by the bursting of bubbles of gas or common air.

For this purpose air was drawn by extremely gentle aspiration (Fig. 7) through the sewage (f), the bubbles breaking in the atmosphere above, whence the air was aspirated, so as to pass through the infusion (d).

Although the formation of the bubbles was gentler than in much natural fermentation (only two-third liters, in some cases, per day being aspirated), the infusion in all three flasks became infected within a few days.

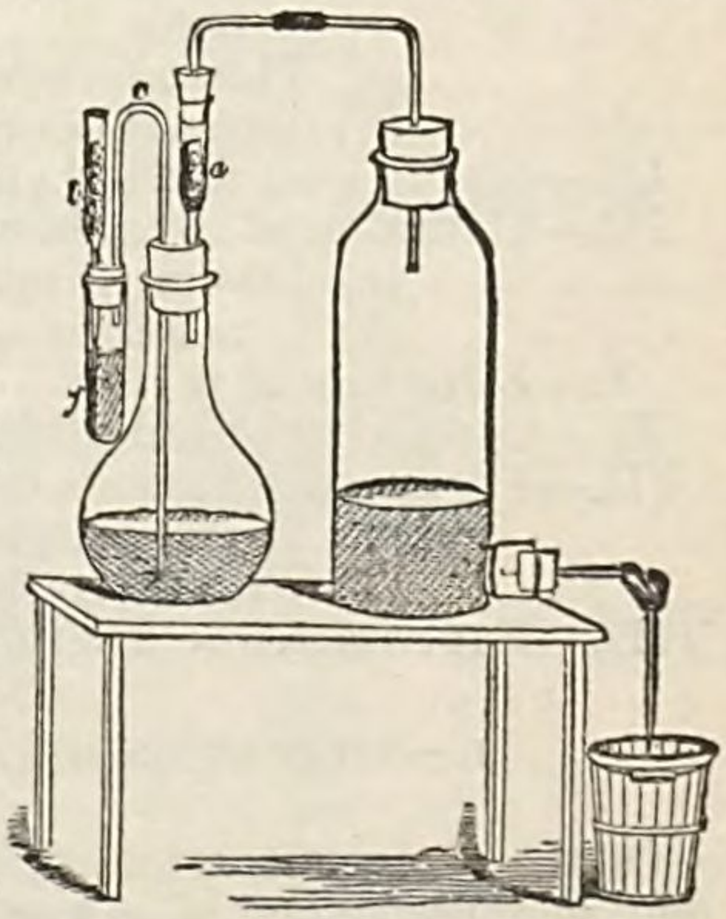


FIG. 7.

These results are positive as far as they go, and show that particulate matter, however minute, cannot pass from the surface of a quiet liquid into the atmosphere under the conditions surrounding our experiments, whereas, on the other hand, the bursting of even the gentlest bubbles can effect such a transfer. They are not, however, sufficiently positive with regard to higher temperatures; needing to be repeated in breeding boxes at regulated temperatures.

Experiments are also needed as to the effects of growths of mould on the surface in forming a transitional condition from which a transfer might be effected; also as to the influence of the evaporation to dryness of infected moisture raised by capillary attraction.

SECOND REPORT.

Since the former report* our work has aimed almost wholly to repeat quantitatively the former experiments, and to carry them out to the end. I will recall briefly the results then reported.

I. It was found that sterilized beef infusion in tubes had been till then (*i. e.*, for three to eight months) perfectly protected from the entrance of bacteria spores by filters of over one millimeter thickness of asbestus, sand, loess, charcoal, animal-charcoal, or coal ashes, provided the grain of these substances was small enough to pass through a sieve of twenty holes to the linear inch.

It was also shown that the same filters saturated with sterilized water were equally protective.

Experiments had also been begun to ascertain the limit of efficiency of the substances used as filters, by determining the volume of air that could be drawn through, first, the filter, and then the infusion, before infecting the latter. Two series, one of slow and one of rapid filtration, had been under way for several months without having reached the limit.

These experiments had all demonstrated that a great capacity for arresting the passage of particulate matter floating in the air, however minute (including the most minute spores), is inherent in material permeated by fine and labyrinthine passages, if only these passages be as small as the interstices between grains less than one-twentieth inch in diameter.

In striking contrast to these results were those obtained in attempting to filter spores from liquids. It was found that while closely packed asbestus, clay, and very fine animal-charcoal possess a very slight filtering capacity, sand, no matter how fine, presented absolutely no resistance to the passage of spores, even when the filter was a column of one hundred feet of sterilized sand of the finest grain.

In another series of experiments it was shown that, at least at ordinary temperatures, spores cannot detach themselves from a quiet liquid. A vessel containing sewage suspended over sterilized beef infusion in a flask failed to infect the air and infusion, even after months of exposure. At the same time it was found that the slightest bubbling of the liquid liberated these spores at once into the atmosphere.

The work done since the former report has been:

I.—Passive filtration of AIR through DRY filters of "SPONGY IRON."
II.—SLOW quantitative AIR filtration.
- (*a*) Through dry sterilized filters.
- (*b*) Through dry unsterilized filters.
- (*c*) Through filters moistened with sterilized water.
- (*d*) Through filters moistened with unsterilized water.
- (*e*) Through filters moistened with putrescible liquids at temperature of the laboratory.
- (*f*) Through filters moistened with putrescible liquids at higher temperatures.
- (*g*) Through open tubes with disk of gauze.
- (*h*) Through open tubes without gauze.

III.—RAPID quantitative AIR filtration.
IV.—Filtration of PUTRESCIBLE INFUSIONS.
- (*a*) Into sterilized empty tubes.
- (*b*) Into sterilized infusions.

V.—Filtration of WATER.
VI.—Capillary upward filtration.
VII.—Further experiments on the TRANSMISSION of SPORES from LIQUID to AIR.
- (*a*) Without aspiration.
- (*b*) With aspiration.

VIII.—Experiments to determine the presence of bacteria in dry soils in depth.

I.—FILTRATION OF AIR THROUGH DRY FILTERS OF SPONGY IRON.

Of the 81 dry filters for air, which were intact at the time of the last report, all but four were perfect at the suspension of the work in June, after two years.

On March 24, 1881, we added thirty-six filters of spongy iron. The apparatus used was the same, the filter of spongy iron being placed on a wire gauze above the narrowed neck of a tube containing beef infusion. In these also the filtration was passive, the passage of the air being promoted only by natural changes of temperature. (Fig. 1, p. 580.)

*Supplement No. 13, National Board of Health Bulletin, April 16, 1881.

The results are summarized below :

[Columns 5mm., 1cm., 2cm., an equal number in each set.]

Kind of filter.	Grains per linear inch.*	Remarks.
6 tubes, spongy iron	50—100	All uninfected.
6 tubes, spongy iron	30— 50	All uninfected.
6 tubes, spongy iron	20— 30	4 uninfected { 1 (5mm.) decomposed after 304 days. 1 (1cm.) decomposed after 26 days.
9 tubes, spongy iron	15— 20	8 uninfected 1 (2cm.) decomposed after 347 days.
9 tubes, spongy iron	10— 15	8 uninfected 1 (1cm.) decomposed after 347 days.

*Indicated by the number of meshes to a linear inch in the sieves employed to grade the material. Thus 50—100 means the sand that after passing through a sieve of 50 meshes to the linear inch was arrested by one of 100 meshes.

Of these thirty-six tubes, thirty-two were intact at the suspension of work in June, 1882.

II.—SLOW QUANTITATIVE AIR FILTRATION.

a.—Through dry sterilized filters.

The object of these tests was to determine the volume of air that could pass through filters of different grades of porosity without destroying their capacity for arresting spores. For this purpose we used the apparatus already described in the former report, and which is represented in Fig. 2, p. 581, in which *c* is the material to be tested as a filter, and rests on the wire gauze *b*. The tube containing the filter is drawn out to a point, which is submerged in the sterilized beef infusion *d; e* is the packing of sterilized asbestus, into which is also introduced the aspirating tube *f*. By the action of an aspirator a current of air was drawn through the filter and through the infusion and out at *f*. The length of the filtering column was uniformly 10cm., and its diameter 1cm. for the finer grades and $1\frac{1}{2}$cm. for the coarser. The rate of filtration was from 2 to 7 liters per day. The substances tested were SAND, SPONGY IRON, VEGETABLE CHARCOAL, ANIMAL CHARCOAL, LOESS.

At the date of the former report eight experiments had been started with dry sterilized filters of sand, asbestus, charcoal, and animal charcoal. Of these there were three uninfected at the time of the report, and one of these—sand 30°–40°—broke down through accident before the publication of the report. The other two—charcoal and animal charcoal—were uninfected at the time of the suspension of the work.

The results are summarized as follows :

[Filter columns 10cm. long; rate of filtration 2 to 7 liters per diem.]

Number and kind of filters.	Grains per linear inch.	Number of liters aspirated.	Remarks.
SAND.			
1	100 and finer	1225	UNINFECTED.
1	50—100	1708	UNINFECTED.
1	25—100	70	Decomposed.
1	30— 50	149	Do.
1	25— 30	490	Do.
1	20— 25	84	Do.
1	18— 20	182	Do.
1	16— 18	91	Do.
1	14— 16	70	Do.
1	12— 14	70	Do.
1	10— 12	40	Do.
1	9— 10	77	Do.
1	8— 9	182	Do.
1	7— 8	49	Do.
1	6— 7	84	Do.
GRAVEL.			
1	5— 6	49	Do.
1	4— 5	147	Do.
1	3— 4	91	Do.

Number and kind of filters.	Grains per linear inch.	Number of liters aspirated.	Remarks.
SPONGY IRON.			
1	50—100	1148	Decomposed.
1	30— 50	420	Do.
1	20— 30	84	Do.
1	15— 20	147	Do.
1	10— 15	84	Do.
CHARCOAL.			
1	25— 50	1898	UNINFECTED.
1	25— 30	1708	UNINFECTED.
ANIMAL CHARCOAL.			
1	20—100	194	Decomposed.
1	10— 15	210	Do.
LOESS.	Impalpable	84	Do.

For comparison, air was aspirated through eight tubes, each fitted with a disk of copper gauze, but carrying no filtering material, with results as follows:

Meshes to linear inch of gauge.	Number of liters aspirated.	Duration of aspiration, in days.	Remarks.
80	$1\frac{1}{10}$	4	Decomposed five days after last aspiration.
80	35	5	Decomposed one day after last aspiration.
25	28	4	Decomposed one day after last aspiration.
25	25	$3\frac{1}{2}$	Decomposed one day after last aspiration.
25	49	7	Decomposed one day after last aspiration.
25	42	6	Decomposed one day after last aspiration.
25	21	3	Decomposed one day after last aspiration.
25	42	6	Decomposed one day after last aspiration.

Beef infusion exposed in an open dish usually shows signs of decomposition within forty-eight hours.

b.—Through dry unsterilized filters.

These were begun just before the suspension of the work.
There were four filters representing the different grades of sand and gravel used in *a*.
All but one—the coarsest—were standing intact after the passage of 231 liters of air.

II *b.—Slow quantitative air filtration through dry unsterilized filters.*

Kind of filter.	Length.	Grains per linear inch.	Number of liters aspirated.	Remarks.
Sand		100	231	Uninfected.
Sand		30—50	231	Uninfected.
Sand		18—20	231	Uninfected.
Sand		5— 6	84	Decomposed.

A glance at this and the previous tables shows that a great difference exists between the filtering capacity of fine and moderately fine grains. Sizes above a certain degree of fineness have a capacity relatively low to that of all finer grades.

To determine the critical point in the scale will require a larger number of filters of each grade to be tested. In the case of the filter of impalpable loess the test was clearly defective, for the air-current appeared to have opened a channel through the filter.

THROUGH MOISTENED FILTERS.

It was intended in these experiments to keep the filters moistened sufficiently to surround each grain with a film of moisture without filling the interstices and thus destroying the porosity.

The material to be tested as a filter was contained in a U-tube (*c*) connected with the flask containing the infusion by a long, thin arm, the point of which was submerged in infusion (*d*).

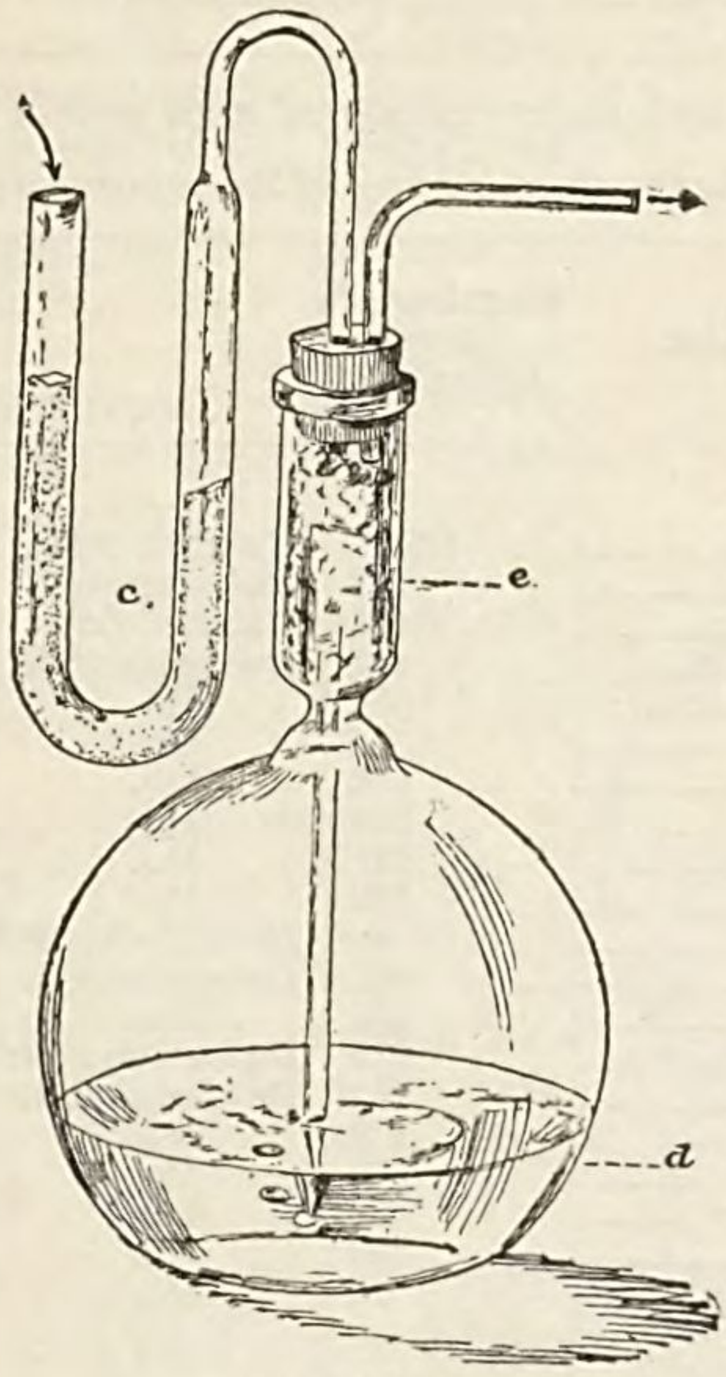


FIG. 3 *a*.

c.—Through filters moistened with sterilized water.

[Filter-columns 10 cm. long; rate, 4, 2, or 7 liters per diem.]

Kind of filter and size of grain.	Number of liters aspirated.	Remarks.
LOESS.		
Impalpable	84	
SAND.		
100 and finer	**1,691**	UNINFECTED.
50—100	466	Decomposed.
10—100	905	Do.
30— 50	**1,691**	UNINFECTED.
25— 30	298	Decomposed.
20— 25	305	Do.
18— 20	**1,106**	UNINFECTED.
16— 18	**1,106**	UNINFECTED.
14— 16	1,043	Decomposed.
12— 14	217	Do.
10— 12	630	Do.
9— 10	658	Do.
8— 9	154	Do.
7— 8	171	Do.
6— 7	70	Do.
GRAVEL.		
5— 6	119	Do.
4— 5	147	Do.
3— 4	84	Do.

d.—Through filters moistened with unsterilized water.

Kind of filter and size of grain.	Number of liters aspirated.	Remarks.
SAND.		
10—100	382	Decomposed.
30— 50	252	UNINFECTED.
18— 20	252	UNINFECTED.
8— 9	63	Decomposed.

e.—Through filters moistened with putrid liquids.

[At the temperature of the laboratory.]

Kind of filter and size of grain.	Number of liters aspirated.	Remarks.
SAND.		
100 and finer	**1691**	UNINFECTED.
50—100	123	Decomposed.
10—100	**266**	UNINFECTED.
30— 50	861	Decomposed.
25— 30	550	Do.
20— 25	403	Do.
18— 20	672	Do.
16— 18	546	Do.
14— 16	441	Do.
12— 14	343	Do.
10— 12	98	Defective; bubbled and decomposed.
10— 12	462	Decomposed.
9— 10	266	Do.
8— 9	119	Defective; bubbled and decomposed.
8— 9	112	Decomposed.
7— 8	119	Do.
6— 7	203	Do.
5— 6	32	Do.
4— 5	399	Do.
3— 4	70	Do.
LOESS.		
Impalpable	144	Do.

Comparison experiments made with similar apparatus but with filter-tubes containing neither gauze nor filtering material resulted as follows:

Number of liters aspirated.	Duration of aspiration, in days.	Remarks.
7	1	All decomposed either upon the day of the last aspiration or on the day following.
31	4½	
42	6	
45	6½	
50	7	
66	9½	
70	10	

f.—Through filters moistened with putrid liquids.

[At temperatures ranging from 30° to 60° C.]

Kind of filter and size of grain.	Number of liters aspirated.	Remarks.
SAND.		
100 and finer	690	UNINFECTED.
50—100	690	UNINFECTED.
10—100	650	UNINFECTED.
30— 50	128	Defective; decomposed.
25— 30	56	Opened for examination.
20— 25	660	UNINFECTED.

The rapid evaporation taking place at this temperature necessitated frequent addition of sewage to maintain the condition of moisture; and this doubtless caused a diminution in the size of the interstices and also produced a more sure entanglement of the spores in the gelatinous mass.

III.—RAPID QUANTITATIVE AIR FILTRATION.

Through sterilized dry filters.

The object of these experiments was to determine the effect of velocity in filtration. For this purpose, by means of an aspirator, air was drawn through the filter (*c*), Fig. 3 *a*, and made to emerge just over the surface of the sterilized beef infusion. Each grade of filter was tested under increasing rates of aspiration, for the purpose of determining the velocity at which the resistance of the filter to the passage of infection was overcome.

The series which was in progress at the time of the former report was continued until it appeared that the passage of one liter of air in from eleven to forty seconds, through columns from 9^{cm}. to 25^{cm}. in length, was insufficient to produce infection. Realizing, therefore, the great capacity of the filters, a new series of experiments was started in which the filtering columns were taken 10^{cm}. long, and the volume of air to be passed was fixed at ten liters instead of one; the filtering material employed being sand of various grades.

In all the filters in the grades from 100° to 14° it was found necessary, in order to induce infection, to shorten the column to 1^{cm}. and in the two finest to 5^{mm}. In the coarser grades columns of 10^{cm}. were retained. After each aspiration the apparatus was placed in the cultivating chamber, and it was sterilized before again aspirating. The results are summarized in the following table:

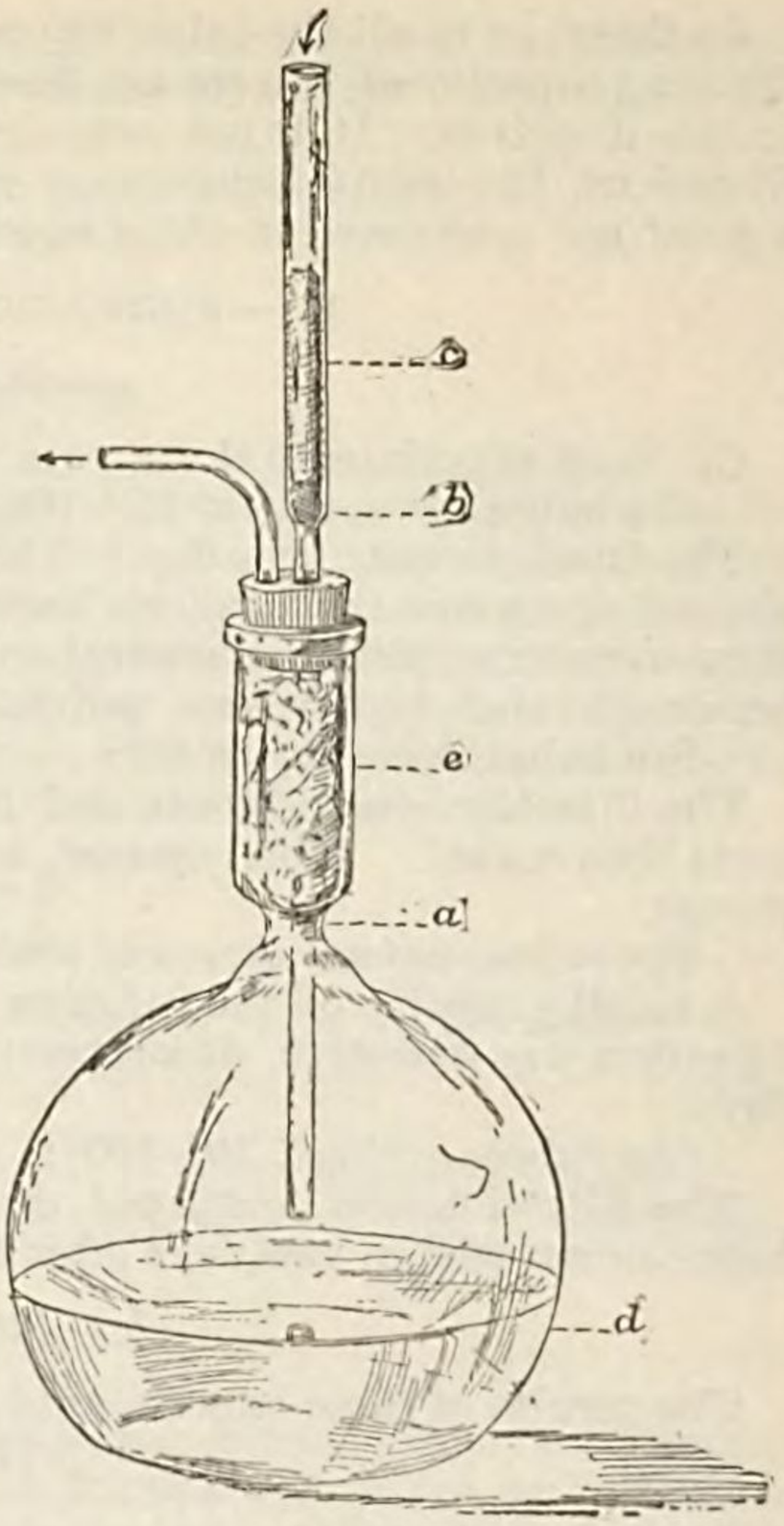


FIG. 2 *a*.

Kind of filter and size of grain.	Final rate of passage of 10 liters through columns 10^{cm}. high, in seconds.	Final rate of passage of 10 liters through columns 1^{cm}. high, in seconds.	Final rate of passage of 10 liters through column 5^{mm}. high, in seconds.	Remarks.
SAND.				
100	.....	.....	36	Decomposed.
50—100	.....	*45	.....	UNINFECTED.
10—100	.....	36	.....	Decomposed.
30—50	.....	100	.....	Do.
25—30	.....	100	.....	Do.
20—25	.....	120	.....	Do.
18—20	.....	178	.....	UNINFECTED.
16—18	.....	270	.....	Decomposed.
14—16	.....	237	.....	Do.
12—14	100	.....	.....	Do.
10—12	33	.....	.....	Do.
9—10	55	.....	.....	Do.
8— 9	240	.....	.....	Do.
7— 8	60	.....	.....	Do.
6— 7	81	.....	.....	Do.
5— 6	240	.....	.....	Do.
4— 5	302	.....	.....	Do.
3— 4	151	.....	.....	Do.

* This rate was attained with the column 1^{cm}. high without breaking down. The column was then shortened to 5^{mm}., but at the date of suspension a rate of 224 seconds only had been reached.

The influence of the size of the grain is here very evident (especially in the grades finer than 14°), the finer grades admitting a more rapid rate than the coarser ones.

It is clear that 10 liters of air can be drawn through a long filter column much more rapidly, without bringing spores entirely through, than it can be through a column one-tenth as long. As a fact, the detailed tables show that in some of the filters, which in shortened columns broke down at a velocity of ten liters in 100, 120, 270 seconds, a velocity of 10 liters in 40 and 42 seconds was attained in the long columns without breaking down.

In these, as in all the other dry-air filtrations, there appears to be a limit to the air-filtering capacity of the coarser grades, but further manifolded experiments are needed in this direction. It is not improbable that in the coarser grades, especially in rapid filtrations, the results would vary with the abundance or scarcity of spores in the air, a point not considered in these experiments.

IV.—FILTRATION OF PUTRESCIBLE INFUSIONS.

a.—Into sterilized empty tubes.

Of these experiments there were four sets:—

Six tubes, *spongy iron*, 25°–100°:

The filtration lasted one day. The necks were then hermetically sealed. When opened six and seven months later, no bacteria were found, and the infusions not decomposing they were submitted to chemical analysis and found to have been deprived wholly of albuminoids and phosphates. Sulphate of lime was found.

Six tubes, *asbestus, packed:*

The filtration was difficult and repeated three times during nine days. The tubes were then sealed. When opened, several months later, the infusions broke down on exposure.

Six tubes, *animal charcoal*, 100°:

A small quantity of the infusion passed the filters; and excepting two, in which the filtration was defective, decomposition was observed in all cases in from nine to eleven days.

Six tubes, *carferal*, 10°–100°:

The filtration was continued during four consecutive days. Five of the infusions broke down within two days after filtration, and one in four days.

b.—Into sterilized beef infusion.

The results of these experiments are summarized as follows:

[Filter-columns 15cm, long.]

Kind of filter and size of grain.	Remarks.
SPONGY IRON.	
25—100	Defective.
25—100	UNINFECTED.
10— 80	UNINFECTED.
10— 80	UNINFECTED.
CARFERAL.	
10—100	Decomposed tenth day after filtration.
10—100	Do.
10—100	Do.
10—100	Decomposed second day after filtration.
10—100	Decomdosed tenth day after filtration.
10—100	Do.

V.—FILTRATION OF WATER.

This series was a continuation of the water-filtration experiments described in Table III of the former report.

In these new experiments the filters used were spongy iron and carferal in columns of 15 centimeters in height. The results are summarized below:

Kind of filter and size of grain.	Rate and duration of filtration.	Remarks.
SPONGY IRON.		
25—100	2–3cm daily during 18 days, nearly filling the tubes.	UNINFECTED.
25—100		UNINFECTED.
25—100		UNINFECTED.
25—100		UNINFECTED.
25—100		UNINFECTED.
25—100		UNINFECTED.
20— 30	50cm in a few hours	Decomposed.
25—100		Do.
CARFERAL.		
10—100	Small quantities during 3 days	Do.
10—100		Do.
10—100		Do.
10—100		Do.
10—100		Do.
10—100		Do.
10—100	50cm in a few hours	Do.

From these experiments in filtering putrescible infusions and water, it is evident that:

1st. *Spongy iron* not only filtered out the spores, but also eliminated the albuminoids and phosphates.

2d. The *asbestus* filtered out the spores, but not the organic matter.

3d. The *animal charcoal* failed to act as a filter for spores.

4th. The *carferal* also failed as a filter.

VI.—CAPILLARY FILTRATION.

In these experiments an inverted U-tube was employed, one leg of which was drawn out to small diameter and descended through the usual asbestus packing into a flask containing beef-infusion, nearly to the surface of the liquid. The other leg, loosely plugged with asbestus at the lower end and filled above this to the arch with sand, dipped beneath water in such manner that the latter was carried by capillarity to the arch. To accomplish the actual descent of the water into the infusion it was found necessary to apply a slight suction. The experiments are summarized below:

[Filtering column 15cm.]

Kind of filter and size of grain.	Rate and duration of filtration.	Remarks.
SAND.		
100 and finer	One or more drops at intervals of from two to four days.	Decomposed on 8th day.
100 and finer		Decompcsed on 10th day.
50—100		Decomposed on 8th day.
50—100		Do.

It would appear that the first inference from these experiments is that no substance sufficiently porous to allow of the passage of water can eliminate spores or bacteria from that water, even when moving upward by capillary attraction. There is no current so gentle that it cannot buoy these infinitesimal bodies.

While the spores are immensely retarded in their passage through comparatively coarse filters when buoyed by even rapid air-currents, they are when suspended in water but very slightly retarded by extremely fine substances, and it is not improbable that the same force which prevents particulate matter from disentangling itself from the surface of a liquid and floating into the air, also prevents the lodgment of these minute particles in the labyrinthine interstices of the filter, saturated with the liquid. Of course as an additional fact or the much greater buoying power of water.

In the case of the filtration with putrid infusions the increased filtering capacity shown in the experiments at the higher temperatures is probably due, in the first place, to the fact that the rapid evaporation leaves a sticky residue throughout the pores of the filter which arrests the spores; and, secondly, to the fact that the accumulation of this same residue gradually fills the pores and so makes really filters of much finer grade out of relatively coarse ones.

VII.—TRANSMISSION OF SPORES FROM LIQUIDS INTO AIR.

a.—Without aspiration.

In the experiments described in the former report it was found that sewage could be suspended in a sterilized atmosphere over sterilized beef infusion (see Fig. 5), without infecting the latter at the ordinary temperature of the room.

Of the six instances of passive exposure there described one met an accidental end, and of the five others two were uninfected at the cessation of the work, after about fifteen months passive exposure. But two had broken down under circumstances that suggested the possibility of the transmission of the spores having been effected by evaporation at a higher temperature.

It had been stated that spores can pass over with the vapor of evaporation.

To obtain further light on this point nine experiments were made, and maintained at temperatures ranging from the ordinary temperature of the laboratory to 59° C. (See Tables of Temperature, pp. 661, 664.) Of the nine experiments four were with liquids—sewage, urine, beef infusion, water. They required replenishing twice, but in all four the test infusion remained uninfected at the cessation of the work, after about fifteen months.

The remaining five experiments were made with sand saturated with the same liquids—sewage, urine, beef infusion, water. Of these one (that saturated with water) was

defective, owing to a cracked trap (*f*), Fig. 5, and one saturated with beef infusion was accidentally destroyed. One, saturated with urine, remained intact at the cessation of the work, after more than a year; the remaining two (saturated with sewage) broke down after ten months.

Material in trap.	Duration of experiment, in days.	Remarks.
Water		UNINFECTED.
Beef infusion		UNINFECTED.
Urine		UNINFECTED.
Sewage		UNINFECTED.
Sand, 10—100, saturated with water	91	Defective.
Sand, 10—100, saturated with beef-infusion	123	Do.
Sand, 10—100, saturated with urine		UNINFECTED.
Sand, 10—100, saturated with sewage	308	Decomposed.
Sand, 10—100, saturated with fæces and urine	308	Do.

b.—With aspiration.

Another set of experiments had been begun and partly described in the former report; in these the air *above* the infected liquids was continually removed and drawn through the sterilized infusion. For this purpose the apparatus shown in Fig. 6 was used. Air filtered by asbestus in *b*, after passing over the infected liquid in the trap (*f*), was drawn by aspiration at *a* through *c* into the sterilized infusion (*d*.)

Besides the three experiments described in the former report, and in which the infusions were then uninfected, four similar ones were started at the end of February, 1881, and later another series of five in which the traps were filled with sand saturated with the infected liquids. The experiments were conducted at temperatures ranging between 25° and 59° C., and the traps were replenished with the infected material to compensate for evaporation. The results are summarized below:

Material in trap.	Duration of experiment, in days.	Number of aspirations.	Number of liters aspirated.	Remarks.
Beef infusion	80	57	216	UNINFECTED.
Beef infusion	377	91	344	UNINFECTED.
Urine	377	91	344	UNINFECTED.
Sewage	243	39	140	Defective.
Sewage and urine	80	57	216	UNINFECTED.
Fæces and urine	80	57	216	UNINFECTED.
Water	82	57	216	UNINFECTED.
Sand, 10—100, saturated with beef infusion	319	92	346	UNINFECTED.
Sand, 10—100, saturated with urine	167	64	236	Defective.
Sand, 10—100, saturated with sewage	299	84	316	UNINFECTED.
Sand, 10—100, saturated with fæces and urine	156	55	200	Defective.
Sand, 10—100, saturated with water	104	33	116	Decomposed.

In the two experiments in which sand saturated with beef infusion and with sewage was employed, the air was passed through chloride of calcium tubes before entering the trap, during the greater part of the experiment, with the effect of both preventing condensation of moisture on the tube (*c*), and drying the inner side of the saturated sand-trap (*f*).

VIII.—EXPERIMENTS TO DETERMINE THE PRESENCE OF BACTERIA IN DRY SOILS AT VARIOUS DEPTHS.

Only a slight beginning was made in this direction. The apparatus used in sampling was a piece of five-eighths-inch gas-pipe, reamed out in such a manner that the interior diameter increased from one end to the other. This was fitted with a plug of asbestus at each end and then sterilized by heat. The samples were taken from well-excavations, and a fresh face was obtained by picking away the soil; a large blow-pipe flame was then kept playing on the spot and the sharpened end of the tube (that with the smallest interior diameter) was driven an inch or more into the soil, carrying the sterilized asbestus

plug before it. These tubes were inserted through the rubber cork of the testing flask (the inserted end having been sterilized by heat), and the material was shoved through, being protected in the rear by the asbestus plug, until a portion dropped into the infusion.

Only four satisfactory tests were made. These were on the glacial till, a hard, blue clay in a well newly dug in a virgin field. There was no ground-water in the soil; it was dry, and the slate-rock beneath was both dry and much shattered.

One sample taken 1 foot below the surface produced infection.

One sample taken from 2 feet below the surface produced infection.

One sample taken from 6 feet below the surface produced infection.

One sample taken from 9 feet below the surface failed to produce infection.

These first few results are given merely to show that the method is a practical and promising one for further work.

SUMMARIZED STATEMENT OF EXPERIMENTS.

PASSIVE AIR-FILTRATIONS.

Dry Filters.

[Nos. 1 to 173 appeared in former bulletin]

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
					1880.						
1	Beef	Fig. 1.—Tubes, 46 by 2cm, inner diameter.	Asbestus (loosely packed).	14	June 9	No. 1, air sucked out several times June 21.	1	.....	.....	.....	
2				7			2	.....	.....	.....	
3			Asbestus (tightly packed).	7			3	.....	.....	.....	
4			Sand, 25° to 30°	15	June 10	Air sucked out of Nos. 4 and 5 several times June 21.	4	.....	.....	.....	
5			Sand, 100°	14			5	.....	.....	.....	
6				8			6	.....	.....	.....	
7			Open, for comparison	.....	June 9	.....	7	June 11	Less than 2 days.		
8							8				
9							9				
10	Beef	Flask, 750cm3	Asbestus	8	June 10	.....	10	.....	.....	.....	
11	Beef	Flask, 750cm3	Open	.....	June 10	.....	11	June 12	Within 3 days.		
12*	Beef	Tubes, 46 by 2cm	Sand, 25° to 30°	15	June 9	No. 12, opened and exposed for 20 minutes June 17, and for 9 hours June 23.	12*	June 25	About 2 days, 12 hours.		
13*				5	June 9	No. 13, opened and exposed for 3½ hours June 21, and 24 hours June 25.	13*	June 26	Less than 5 days from 1st exposure, within 1 from 2d.		
14				8	June 9	No. 14, subsequently, on July 9, employed as a water-filter (see No. 1, page 646).	14	.....	.....	.....	
15	Beef	Tubes, 23 by 1cm	Asbestus plugs in the necks.	1	June 19	.....	15	.....	.....	.....	
16							16	June 15, 1881, 361 days.			Filamentary fungus.
17	Beef	Tubes, 23 by 1cm	Sand, 25° to 40°	1	June 19	.....	17	.....	.....	.....	
18				0.8			18	.....	.....	.....	
19	Beef	Tubes, 23 by 1cm	Sand, 100°	1.5	June 19	.....	19	Mar. 9, 1882, 628 days.			Fungi.
20†				†			20†	July 25	36†	.....	

21	Beef	Test-tubes with rubber stoppers containing tubes 5mm in diameter, plugged with asbestus.	Asbestus	1	June 19		21			
22							22			
23	Beef	Tubes, 46 by 2cm					23	June 24	About 1 day, 12 hours.	
24							24	June 24		
25	Beef	Tube, 23 by 1cm	*Open*		June 23		25	June 30	7	
26‡		Test-tube containing pieces of copper gauze.					26‡	June 24	1	
27	Beef	No. 27, test-tube drawn out at the middle to a capillary tube 8cm in length.	*Open*		June 28		27	July 2	4	
28		Nos 28 and 29, test-tubes drawn out at the end to long capillary tubes.					28	July 12	14	
20							29	July 2	4	
30		No. 30, test-tube drawn out to a capillary tube and bent over.					30			
31	Beef	Tubes, 23 by 1cm	*Open*		July 13		31	July 15	Less than 2 days.	
32			*Copper gauze in the necks.*		July 13		32	July 19	6	
33							33	July 19	6	
34							34	July 24	11	
35	Beef (See note §.)	Flasks, of 250cm3	Asbestus not ignited				35			
36							36			
37							37			
38			Sand, 30° to 50° unignited.		July 27		38			
39							39			
40			Sand, 25° to 30° unignited.	4			40			
41			‖Absorbent cotton, unsterilized.				41			
42							42			
43							43			
44			¶Non-absorbent cotton, unsterilized.	4	Aug. 2		44	Sept. 7	36	
45							45	Sept. 21	50	
46							46	Sept. 9	38	

* No. 12 was exposed for twenty minutes on the 17th instant without becoming infected, but decomposed in about two and one-half days after the exposure of nine hours on the 23d instant. No. 13 began to decompose within one day after the exposure of twenty-four hours on the 25th instant. The filters were freshly ignited before being replaced. In Nos. 12 to 14 the necks of the tubes were plugged with asbestus; in all the other tubes employed, disks of copper gauze, ordinarily of 80 meshes to the inch, were fitted into the necks, and were covered with a thin layer of sand, of 25° to 30°, whenever very fine filtering media were employed.

† In No. 20 the sand barely covered the copper gauze above the edges, and a small quantity *from the upper layers* gradually worked its way down behind the gauze into the infusion, carrying germs with it.

‡ No. 26. Pieces of copper gauze were added to the infusion to see whether the copper salts formed would affect the development of germs. (See Nos. 1 to 4, page 639.)

§ The filters in tubes 35 to 58, inclusive, were not heated or sterilized in any way. ‖ Surgeon's cotton. ¶ Cotton used for steamboat mattresses, &c.

PASSIVE AIR-FILTRATIONS—Continued.

Dry Filters—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
					1880.			1880.			
47	Beef (See note §, page 595.)	Tubes, 23 by 1cm	Unignited asbestus	1	July 27	In hood, Feb. 26, 1881, to Mar. 18, 1881; mean temp. 38° C., varying between 26° and 45° C.	47	.....	.....	.....	
48							48	.....	.....	.....	
49							49	Aug. 1	35	.....	
50							50	Nov. 12	108	.....	
51			Sand, 30° to 50°, unignited.	1 to 2			51	Aug. 10	44	.....	
52							52	July 30	33	.....	
53							53	Aug. 2	36	.....	
54							54	Nov. 18	114	.....	
55							55	Between Sept. 25 and Oct. 13**.	60 to 78	.....	
56			Absorbent cotton, unsterilized.	1		In hood, Feb. 26, 1881, to Mar. 18, 1881; mean temp. 38° C., varying between 26° and 45° C.	56	.....	.....	.....	
57							57	.....	.....	.....	
58							58	.....	.....	.....	
59	Beef	Tubes, 23 by 1cm	Charcoal 25° to 30°	1.5	Aug. 3		59	Apr. 4, 1882, 609 days.			Fungus.
60							60	.....	.....	.....	
61			Charcoal, 100°				61	.....	.....	.....	
62							62	.....	.....	.....	
63	Beef	Tubes, 23 by 1cm	Animal charcoal, 15°	1 to 2	Aug. 28		63	Sept. 7	10	.....	
64							64	Sept. 18	21	.....	
65							65	Sept. 7	10	.....	
66							66	Oct. 13	Unknown, between 28 and 46 days.		
67							67	Sept. 10	13	.....	
68							68	Sept. 7	10	.....	

69	Beef	Tubes, 23 by 1cm	Animal charcoal, 100°.	0.7	Oct. 19		69				
70				0.7			70				
71				0.2			71				
72				0.6			72				
73				0.1			73				
74				0.4			74				
75	Beef	Tubes, 23 by 1cm	*Open*				75	Oct. 24	5		
76							76				
77	Beef	Tubes, 23 by 1cm	Coal-ashes, 10° to 100°.	0.8	Nov. 3	In hood, Feb. 26, 1881, to Mar. 18, 1881; mean temp. about 38° C., varying between 26° and 45° C.	77				
78				2			78				
79				1			79				
80				1			80				
81				1.2			81				
82				0.7			82				
83			*Open*				83	Nov. 5	2		
84				3	Nov. 4		84	Dec. 7	33		
85							85	Dec. 22	48		
86							86				
87	Beef	Tubes, 23 by 1cm	Sand, 10° to 20°	6	Nov. 4		87	Jan. 5	62		
88							88				
89							89				
90				9	Nov. 4	All not previously decomposed, in hood, Feb. 26, 1881, to Mar. 18, 1881; mean temp., 38° C., with extreme variations from 26° to 45° C.	90				
91							91				
92							92				
93	Beef		*Open*		Nov. 4		93	Nov. 12	8		
94							94	Nov. 10	6		
95	Beef	Tubes, 23 by 1cm	Loess	1	Nov. 4		95	Tube broken, Nov. 5			
96				1			96				
97				1.3			97				
98				1.5			98				
99				1			99				
100				1			100				
101	Beef	Tubes, 23 by 1cm	*Copper gauze*		Nov. 4		101	Nov. 20	16		
102							102	Nov. 11	7		
103††	Milk	Flask, 750cm3	Asbestus	8	June 11	Shaken occasionally	103††	July 2	21		
104	Milk	Flask, 750cm3	*Open*		June 11		104	June 12	1	6	

** The tubes were not examined from the 26th of September to the 12th of October, inclusive.
†† No. 103 showed the first indications of souring on the 2d instant; separation of casein took place very slowly.

PASSIVE AIR-FILTRATIONS—Continued.

Dry Filters—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
					1880.			1880.			
105*†	Milk	Flask, 1 liter	**Asbestus**	6	July 8	Shaken occasionally	105*†	Sept. 6	60		
106‡	Milk, unboiled	Flask, 1 liter	*Open*		July 8		106‡	July 8	**Within 10 hours.**		
107	Milk (See note †.)	Flasks, 250^{cm3}	**Sand, 30° to 50°**	5	July 10	No. 112 shaken violently several times. Nos. 107–110 and 112–114 occasionally shaken.	107†	.....	**Unknown.**		
108							108†				
109			**Sand, 100°**	5			109†				
110§							110§	July 13	3		
111			*Copper gauze*				111†	July 14	3	12	
112	Milk	Flasks, 250^{cm3}	**Asbestus (tightly packed).**	5	July 14		112†	Sept. 6	54		
113							113†	.....	**Unknown.**		
114							114†				
115			*Copper gauze*				115†	July 17	3		
116			*Open*		July 14		116†	July 17	3		
117	Milk, unboiled	Flask, 250^{cm3}	*Open*				117†	July 15	**Less than 24 hours.**		
118	Hay	Flask, 100^{cm3}	**Asbestus**	1	July 1		118	.....	.....	.....	
119	Hay	Flask, 1 liter	**Asbestus**	1	July 1	No. 119 opened several times and portions taken for the tubes of subsequent experiments; reboiled and asbestus plug reinserted.	119	.....	.....	.....	
120	Hay	Tubes, 23 by 1^{cm}	**Asbestus**	1	July 1		120	.....	.....	.....	
121				0.8			121	.....	.....	.....	
122			**Sand, 30° to 50°**	0.6			122	.....	.....	.....	
123				0.3			123	.....	.....	.....	
124‖			**Sand, 100°**	(‖)			124‖	July 29	28‖	.....	
125				0.4			125	.....	.....	.....	
126	Hay	Tubes, 23 by 1^{cm}	*Open*	.....	July 1		126	July 12	11	.....	
127				.....	July 13		127	July 19	6	.....	

128	Hay	Tubes, 23 by 1cm	*Copper gauze*	.....	July 2		128	July 14	12	.....
129							129	July 25	12	.....
130				.....	July 13		130	July 19	6	.....
131							131	July 19	6	.....
132	Hay	Test-tubes	*Open*	.....	June 30		132			
133							133			
134		Capsule					134	July 1	Less than 24 hours.	
135							135			
136		Flasks					136			
137	Fish	Flask, 200cm3	**Asbestus**	5	July 15		137	.....	.....	.....
138	Fish	Tubes, 23 by 1cm	**Asbestus**	1.3			138	.....	.....	.....
139				1			139	.....	.....	.....
140			**Sand, 30° to 50°**	0.2			140	.....	.....	.....
141				0.1			141	.....	.....	.....
142			**Sand, 100°**	0.5	July 15		142	.....	.....	.....
143				0.8			143	.....	.....	.....
144			*Open*	.....			144	July 20	5	.....
145			*Copper gauze*	.....			145	July 21	6	.....
146							146	July 29	14	.....
147	Cucumber	Flasks, 200cm3	**Asbestus**	5	July 22		147	.....	.....	.....
148							148	.....	.....	.....
149	Cucumber	Tubes, 23 by 1cm	**Asbestus**	0.8			149	.....	.....	.....
150							150	.....	.....	.....
151			**Sand, 30° to 50°**	0.1	July 22		151	Dec. 15	146	.....
152				0.2			152	.....	.....	.....
153¶			**Sand, 100°**	(¶)			153¶	Nov. 24	125¶	.....
154¶							154¶	Oct. 18	88¶	.....

* No. 105 was not boiled until noon, and had just begun to turn, showing slight acid reaction. It was boiled in a paraffine bath for over an hour, the temperature of the bath being about 110°. Coagulated rapidly, and subsequently putrefied.

† The flasks were boiled in a paraffine bath for a long time, at temperatures ranging from 101° to 110°. Nos. 107–109, and 113 and 114 remained for several months apparently unchanged. Casein separated in very small amounts in granular masses, which, for the most part, remained suspended in the milk. The separation proceeded so slowly that no date of incipient decomposition could be assigned. Nos. 107 and 113, opened on January 22, gave acid reaction and a peculiar odor resembling that of unsalted butter which has stood for a long time. Under the microscope (Zeiss, $\frac{1}{12}$ homogeneous oil-immersion), spherical cells, resembling colostrum-corpuscles which are stained by anilin-violet, were observed. No bacterial growths could be found in any portions. No. 105 contained the same spherical cells in addition to bacterial forms. Nos. 108 and 109 were not examined microscopically. No. 112, examined under the microscope (Hartnack, nine, water-im. objective), December 18, was found to contain living bacteria in great abundance. The casein separated out very rapidly after the first indications of souring. No. 114, as also Nos. 108 and 109, opened February 11, gave same oily odor, &c., as Nos. 107 and 113. No bacteria could be found in No. 114 (Hartnack, nine, water-im. objective); contained spherical cells similar to those in Nos. 107 and 113.

‡ No. 106 was not boiled, and had soured completely by 3.30 p. m. Temperature, 30° C.

§ Putrefied.

‖ Case similar to No. 20.

¶ Cases similar to Nos. 20 and 124

PASSIVE AIR-FILTRATIONS—Continued.

Dry Filters—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
					1880.			1880.			
155	Cucumber	Tubes, 23 by 1cm	*Open*		July 22		155	July 23	1	9	
156							156	July 24	2	.....	
157			*Copper gauze*				157	July 24	2	.....	
158							158	July 25	3	.....	
159	Cucumber	Flasks, 100cm3	*Open*	.....	July 22	.....	159	July 23	Less than 21 hours.		
160			*Copper gauze*				160				
161	Beet	Flask, 200cm3	Asbestus	5	July 22	.....	161	.....	.....	.....	
162	Beet	Tubes, 23 by 1cm	Asbestus	1	July 22	.....	162	.....	.....	.....	
163				1.4			163	.....	.....	.....	
164			Sand, 30° to 50°	0.3			164	.....	.....	.....	
165							165	.....	.....	.....	
166			Sand, 100°	0.7			166	.....	.....	.....	
167				0.3			167	1881. Mar. 28	249	.....	Fungoid growths on sides of tube above liquid. Up to April 12, 1881, fungi developed very slowly.
168	Beet	Tubes, 23 by 1cm	*Open*		July 22	.....	168	1880. July 25	3	.....	
169							169	July 27	Less than 5 days.		
170			*Copper gauze*				170	July 24	2	.....	
171							171	July 28	6	.....	
172	Beet	Flasks, 100cm3	*Open*	.....	July 22	.....	172	July 24	2	.....	
173			*Copper gauze*				173	July 24	2	.....	
174	Beef	Fig. 1, tubes, 23 by 1cm	Spongy iron, 50° to 100°.	0.5	March 24, 1881.	Cultivating chamber, Mar. 25, 1881, to Apr. 2, 1881; mean temp., 37° C., varying from 31° to 44° C.	174	.....	.....	.....	
175							175	.....	.....	.....	
176				1			176	.....	.....	.....	
177							177	.....	.....	.....	

178	Beef	Fig. 1, tubes, 23 by 1cm.	Spongy iron, 50° to 100°.	2	March 24, 1881.	Cultivating chamber, Mar. 25, 1881, to Apr. 2, 1881; mean temp., 37° C., varying from 31° to 44° C.	178	.....	.....	.....	
179							179	.....	.....	.....	
180			Spongy iron, 30° to 50°.	0.5			180	.....	.....	.....	
181							181	.....	.....	.....	
182				1			182	.....	.....	.....	
183							183	.....	.....	.....	
184				2			184	.....	.....	.....	
185							185	.....	.....	.....	
186			Spongy iron, 20° to 30°.	0.5			186	Jan. 22,'82	304	.....	Cloudy from bacteria.
187							187	.....	.....	.....	
188				1			188	.....	.....	.....	
189							189	Apr. 19,'81	26	.....	Tube broken by accident Mar. 28, 1881.
190				2			190	.....	.....	.....	
191							191	.....	.....	.....	
192			Spongy iron, 15° to 20°.	0.5			192	.....	.....	.....	
193							193	.....	.....	.....	
194							194	.....	.....	.....	
195				1			195	.....	.....	.....	
196							196	.....	.....	.....	
197							197	.....	.....	.....	
198				2			198	.....	.....	.....	
199							199	Mar. 6, '82	347	.....	Fungi.
200							200	.....	.....	.....	
201			Spongy iron, 10° to 15°.	0.5			201	.....	.....	.....	
202							202	.....	.....	.....	
203							203	.....	.....	.....	
204				1			204	.....	.....	.....	
205							205	.....	.....	.....	
206							206	Mar. 6, '82	347	.....	Fungi.
207				2			207	.....	.....	.....	
208							208	.....	.....	.....	
209							209	.....	.....	.....	

NOTE.—A large number of infusions of beef, hay, fish, cucumber, and beet, exposed in test-tubes, flasks, and capsules in different parts of the laboratory for comparison with these, broke down within *thirty hours*; some within *twenty-four hours*. None remained clear over thirty hours.

PASSIVE AIR-FILTRATIONS.

Wet Filters.

[This table appeared in former bulletin.]

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—	
			Kind.	Length in centimeters.					Days.	Hours.
1*	Beef	Tubes, 46 by 2cm (See figure 1.)	Sand, 25 to 40°	17	1880. June 18		1*	1880. June 23	5*	
2				7			2			
3*			Sand, 100°	17			3*	Aug. 24	67*	
4*				7			4*	June 23	5*	
5			Sand, 25 to 40°	17	June 26		5			
6				7			6			
7			Sand, 100°	17			7			
8				7			8			
9†	Beef	Flask, 200cm3	Asbestus	1.5	June 20		9†			
10	Beef	Tube, 46 by 2cm	Finely-pulverized charcoal.	15	Aug. 3		10			
11	Beef	Flasks, 200cm3	Animal charcoal, mostly 15°.	5	Aug. 28		11	Sept. 7	10	
12							12	Sept. 18	21	
13	Beef	Tubes, 46 by 2cm	Loess	15	Nov. 4		13			
14							14			
15				7			15			
16							16			
17	Hay	Tubes, 46 by 2cm	Sand, 30 to 50°	15	July 1	Water which had been exposed to the air for some time was added to the tubes on the 19th, 20th, 21st, and 22d instants. A few drops filtered through Nos. 1 and 4 each time. Unsterilized water was subsequently added to Nos. 2 and 3 from time to time in sufficient quantity to keep the filters saturated with moisture, but not to run through into the infusions. Nos. 2, 5 to 8, 10, 13 to 19, 25, and 26 were kept saturated with wa-	17			
18				7			18			
19			Sand, 100°	15			19			
20‡				7			20‡	Between July 3 and 7.	Not known; 6 days at the most.‡	
21§	Hay	Flasks, 200cm3	Asbestus (very loosely filled).	2	July 1		21§			
22							22	Dec. 13	164	
23‖					July 2		23‖	July 7	5‖	

24				Asbestus (packed)	5			ter for a long time, and then kept	24			
25	Fish	Flask, 100cm3	Tubes, 46 by 2cm	30° to 50° Sand	10	July 15		moist.	25	Bet. Sept. 25 and Oct. 13.	Not known; more than 72 days; les than 90 days.	
26				100°					26			
27				Asbestus (packed)					27			
28									28			
29	Cucumber (See note ‖.)	Flasks, 100cm3		Sand, 30° to 50°	4	July 22			29			
30									30			
31				Sand, 100°					31			
32									32			
33				Asbestus (packed)					33			
34									34			
35	Beet (See note ‖.)	Flasks, 100cm3		Sand, 30° to 50°	4	July 22			35			
36									36			
37				Sand, 100°					37			
38									38			

* Water filtered through No. 3 on the 23d of August, too large a quantity having been added to supply the loss by evaporation. The infusion broke down within twenty-four hours. The decompositions in Nos. 1 and 4 were likewise probably due to infiltration of unsterilized water.

† No. 9 was boiled, after the addition of asbestus, until the asbestus was thoroughly moistened by the condensed vapors.

‡ The tubes were all clear on the 3d instant, and were not examined again until the 7th instant, when a fungoid growth was found in No. 20. The hay infusions in this tube and in No. 23 were probably not completely sterilized by boiling.

§ No. 21 was boiled until the asbestus was completely saturated with moisture.

‖ No subsequent additions of water to the filters of the cucumber and beet infusions.

QUANTITATIVE AIR-FILTRATIONS.

Slow filtrations through dry sterilized filters.

[Numbers 1 to 6 appeared in old bulletin.]

No.	Infusion.	Dimensions of tubes, &c., employed.*	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	No. of liters of air filtered, up to date of decomposition.
			Kind.	Length in centimeters.					
1†	Beef	Flask, 500^{cm3} (See figure 2.)	**Asbestus**		1880. June 19	Filtration maintained almost constantly, day and night, from June 21 until September 12, inclusive, with the exceptions of July 4, 5, 6, 18, and 19, and August 22 and 23.	1†	1880. Sept. 12	**89 liters.**
2‡	Beef	Flask, 500^{cm3}	**Sand, 100°**	12	June 25	Constantly, from June 25 to July 3	2‡	*See note* ‡.	*About* 14 *liters. See note* ‡.
3	Beef	Flask, 500^{cm3}	**Sand, 25° to 40°**	14	June 26	As the aspiration was not perfectly regular, the apparatus was tested for rapid filtrations under the filter-pump. June 28, aspirated under half-pressure for 5 minutes; June 29, full pressure for over 20 minutes; and July 2, full pressure for 2 hours.	3	Between July 3 and 9.	**Not known.**
4			**Sand, 30° to 40°**			No. 4 constantly, day and night, from July 20 to September 23, inclusive, excepting August 22, 23, and 30, and September 18, 19, and 20; and from October 18 to December 17, inclusive, excepting December 4 to 7, inclusive.	4	Feb. 15, '81	434 *liters. See note* §.
5	Beef (See note §.)	Flask, 1 liter	**Sand, 50° to 60°**	10	July 17	No. 5 constantly, from July 20 to September 23, inclusive, excepting August 22, 23, and 30, and September 18, 19, and 20; and from October 18 to November 2.	5	Nov. 2	258 *liters. See note* §.

6			Sand, 100°.....			No, 6 constantly, from July 20 to July 26, inclusive.	6	July 27	5 *liters after saturation of the filter by the infusion. See note §.*

* The inner diameter of the filter-tube was in all cases 1^{cm}.

† The filtration was carried on 76 days, averaging about $1,171^{cm3}$ per day. The filtration averaged about 2 liters per day for the first month, but was afterwards necessarily carried on somewhat more slowly on account of the persistency of the air bubbles.

‡ Flask broken on the 7th of July.

§ In Nos. 4 and 5 the infusions were occasionally sucked back into the filter-tubes, though without moistening the entire contents of the filters. In No. 5 the infusion ran back into the filter twice during the last week of October, and the upper portions of the sand were found on November 2 to be slightly moistened. In No. 6 the infusion ran back into the filter July 22 and was carried up through the sand column by capillary action, moistening it throughout. On November 27 the filter of 4 was moistened by the infusion. Undoubtedly the decomposition spread downwards through this tube and infected the infusion in the flask. The filtration of No. 4 was carried on 116 days, averaging $3,655^{cm3}$ per day. The filtration of No. 5 was carried on 75 days, averaging $3,444^{cm3}$ per day.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations through dry sterilized filters—Continued.

[Nos. 30 and 32 appeared in former bulletin as Nos. 7 and 8 of Table III.]

No.	Infusion.	Apparatus.	Filter.		Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
			Kind.	Length in centimeters.				
7	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 100°.....	10	Prepared, **Apr. 2,** 1881; put in cultivating chamber, Apr. 2; removed from cultivating chamber, Apr. 9; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15, 17, 23, 29; June 28; July 6, 13; Aug. 7, 15; Sept. 8, 15; Oct. 4, 12, 18, 22, 25, 27; Nov. 12, 14, 16–18, 22–30; Dec. 1–3, 12–22. Jan. 5–29, 1882; Feb. 3–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15. **Not decomposed.**	175	1,225	**Not decomposed.**
8	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 50° to 100°.....	10	Prepared, **Apr. 2,** 1881; put in cultivating chamber, Apr. 2; removed from cultivating chamber, Apr. 9; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27; May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 4–19, 24–26; Sept. 7–9, 12–15. 21–23; Oct. 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22. Jan. 5–31, 1882; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15. **Not decomposed.**	244	1,768	**Not decomposed.**
9	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 25° to 100°.....	10	Prepared, **Feb. 19,** 1881; put in cultivating chamber, Feb. 22; removed from cultivating chamber, Mar. 1; filter changed from 25°–100° to 10°–100°, Apr. 4; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24. Decomposed, **Apr. 24.**	10	70	Filamentary fungi.
10	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 30° to 50°.....	10	Prepared, **Apr. 2,** 1881; put in cultivating chamber, Apr. 2; removed from cultivating chamber, Apr. 9; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27; May 6; June 23–26, 28–30; July 1, 2. Decomposed, **July 6.**	22	149	Filamentary fungi.
11	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 25° to 30°.....	10	Prepared, **Feb. 26,** 1881; put in cultivating chamber, Feb. 26; removed from cultivating chamber, Mar. 10; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27; May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 4–19, 24–26; Sept. 7–9, 12–15, 21–23; Oct. 4–7, 11–16. Decomposed, **Oct. 17,** 1881.	70	490	Fungi.

12	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 20° to 25°.....	10	Prepared, **Feb. 26,** 1881; put in cultivating chamber, Feb. 26; removed from cultivating chamber, Mar. 10; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15-17, 19-24, 26, 27. Decomposed, **Apr. 28,** 1881.	12	84	Minute filamentary fungus.
13	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 18° to 20°.....	10	Prepared, **Oct. 17,** 1881; put in cultivating chamber, Oct. 17; removed from cultivating chamber, Oct. 24; aspirated at rate of 7 liters per diem, Nov. 15–17, 22–30; Dec. 1–3, 12–22. Decomposed, **Jan. 4,** 1882.	175	25	Fungus.
14	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 16° to 18°.....	10	Prepared, **Oct. 18,** 1881; put in cultivating chamber, Oct. 18; removed from cultivating chamber, Oct. 25; aspirated at rate of 7 liters per diem, Nov. 15–17, 22–30; Dec. 1–3. Decomposed, **Dec. 3,** 1881.	91	13	Filamentary fungus.
15	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 14° to 16°.....	10	Prepared, **Oct. 21,** 1881; put in hood, Oct. 21; removed from hood to cultivating chamber, Oct. 22; removed from cultivating chamber, Oct. 28; aspirated at rate of 7 liters per diem, Nov. 15–17, 22–29. Decomposed, **Nov. 29,** 1881.	70	10	Fungus.
16	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 12° to 14°.....	10	Prepared, **Oct. 24,** 1881; put in cultivating chamber, Oct. 24; removed from cultivating chamber, Nov. 14; aspirated at rate of 7 liters per diem, Nov. 15–17, 22–29. Decomposed, **Nov. 29,** 1881.	70	10	Bacteria.
17	Beef.....	.....	Sand, 10° to 12°.....	10	Prepared, **Oct. 25,** 1881; put in cultivating chamber, Oct. 25; removed from cultivating chamber, Nov. 15; aspirated at rate of 7 liters per diem, Nov. 15–17, 22–30; Dec. 1–3, 12–18. Decomposed, **Dec. 19,** 1881.	147	21	Cloudy.
18	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 9° to 10°.....	10	Prepared, **Dec. 2,** 1881; put in cultivating chamber, Dec. 2; removed from cultivating chamber, Dec. 12; aspirated at rate of 7 liters per diem, Dec. 12–22. Decomposed, **Jan. 4,** 1882.	11	77	Fungus.
19	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 8° to 9°.....	10	Prepared, **Dec. 20,** 1881; put in cultivating chamber, Dec. 23; removed from cultivating chamber, Jan. 5, 1882; aspirated at rate of 7 liters per diem, Jan. 6–31. Decomposed, **Feb. 1,** 1882.	26	182	Cloudy.
20	Beef.....	Fig. 2, diameter of tube, 1cm.	Sand, 7° to 8°.....	10	Prepared, **Dec. 21,** 1881; put in cultivating chamber, Dec. 23; removed from cultivating chamber, Jan. 5, 1882; aspirated at rate of 7 liters per diem, Jan. 11–17. Decomposed, **Jan. 18,** 1882.	7	49	Fungus.
21	Beef.....	Fig. 2, tube, 12.5 by 1.5cm.	Sand, 6° to 7°.....	10	Prepared, **Jan. 18,** 1882; put in cultivating chamber, Jan. 18; removed from cultivating chamber, Jan. 25; aspirated at rate of 7 liters per diem, Jan. 25–31; Feb. 1–7. Decomposed, **Feb. 8,** 1882.	12	84	Minute fungus.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations through dry sterilized filters—Continued.

No.	Infusion.	Apparatus.	Filter.		Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
			Kind.	Length in centimeters.				
22	Beef..... ..	Fig. 2, tube, 12.5 by 1.5cm.	Gravel, 5° to 6°	10	Prepared, **Jan. 26,** 1882; put in cultivating chamber, Jan. 26; removed from cultivating chamber, Feb. 6; aspirated at rate of 7 liters per diem, Feb. 9–15. Decomposed, **Feb. 16,** 1882.	7	49	Filamentary fungi.
23	Beef.....	Fig. 2, tube, 12.5 by 1.5cm.	Gravel, 4° to 5°	10	Prepared, **Feb. 18,** 1882; put in cultivating chamber, Feb. 18; removed from cultivating chamber, Feb. 28; aspirated at rate of 7 liters per diem, Mar. 1–21. Decomposed, between Mar. 22 and **Apr. 4,** 1882.	21	147	Small fungus.
24	Beef.....	Fig. 2, tube, 12.5 by 1.5cm.	Gravel, 3° to 4°	10	Prepared, **Feb. 23,** 1882; put in cultivating chamber, Feb. 23; removed from cultivating chamber, Mar. 3; aspirated at rate of 7 liters per diem, Mar. 9–21. Decomposed, between Mar. 22 and **Apr. 4,** 1882.	13	91	Filamentary fungus.
25	Beef.....	Fig. 2, diameter of tube, 1cm.	Spongy iron, 50° to 100°	10	Prepared, **Feb. 19,** 1881; put in cultivating chamber, Feb. 22; removed from cultivating chamber, Mar. 1; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27; May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 4–19, 24–26; Sept. 7–9, 12–15, 21–23; Oct. 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22; Jan. 5–31, 1882; Feb. 1–24, 28; Mar. 1, 2. Decomposed **Mar. 3,** 1882.	164	1,148	Numerous filamentary fungi.
26	Beef.....	Fig. 2, diameter of tube, 1cm.	Spongy iron, 30° to 50°	10	Prepared, **Mar. 1,** 1881; put in cultivating chamber, Mar. 1; removed from cultivating chamber, Mar. 10; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24; 26, 27; May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 4–19, 24–26; Sept. 6–9, 12–15, 21–23. Decomposed, **Oct. 4,** 1881.	60	420	Large fungus, evidently of several days' growth.
27	Beef.....	Fig. 2, diameter of tube, 1cm.	Spongy iron, 20° to 30°	10	Prepared, **Mar. 1,** 1881; put in cultivating chamber, Mar. 1; removed from cultivating chamber, Mar. 10; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27. Decomposed, **Apr. 27,** 1881.	12	84	Filamentary fungi. Subsequently examined microscopically (Oct. 6); no bacteria found.

28	Beef	Fig. 2, diameter of tube, 1cm.	Spongy iron, 15° to 20°	10	Prepared, **Mar. 1,** 1881; put in cultivating chamber, Mar. 1; removed from cultivating chamber, Mar. 10; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27; May 6; June 23–26, 28–30; July 1, 2. Decomposed, **July 6,** 1881.	22	149	Filamentary fungi.
29	Beef	Fig. 2, diameter of tube, 1cm.	Spongy iron, 10° to 15°	10	Prepared, **Mar. 1,** 1881; put in cultivating chamber, Mar. 1; removed from cultivating chamber, Mar. 10; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27. Decomposed, **Apr. 28,** 1881.	12	84	Minute filamentary fungus.
30	Beef	Fig. 2, flask, 1 liter; diameter of tube, 1cm.	Charcoal, 25° to 50°...	10	Prepared, **Oct. 23,** 1880; aspirated *at rate of* 3.88 *liters per diem*, Oct. 26–31; Nov. 1–30; Dec. 1–3, 8–17. Same, *aspirated at rate of* 7 *liters per diem*, Apr. 12, 13, 15–17, 19–24, 26, 27, 1881; May 6; June 23–26, 28, 30; July 1, 2, 7–15; Aug. 4–19, 24–26; Sept. 7–9, 12–15, 21–23; Oct. 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22; Jan. 5–31, 1882; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15, 1882. **Not decomposed.**	292	1,898	**Not decomposed.**
31	Beef	Fig. 2, diameter of tube, 1cm.	Charcoal, 25° to 30°...	10	Prepared **Mar. 7,** 1881; put in cultivating chamber, Mar. 7; removed from cultivating chamber, Mar. 18; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 26, 27; May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 4–19, 24–26; Sept. 7–9, 12–15, 21–23; Oct. 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22; Jan. 5–31, 1882; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15. **Not decomposed.**	244	1,708	**Not decomposed.**
32	Beef	Fig. 2, flask, 1 liter; diameter of tube, 1cm.	Animal charcoal, 20° to 100°.	10	Prepared, **Oct. 30,** 1880; aspirated *at rate of* 4.1 *liters per diem*, Oct. 31; Nov. 1–30; Dec. 1–3, 8–17. Same, *aspirated at rate of* 7 *liters per diem*, Apr. 12, 13. Decomposed, **Apr. 15,** 1881.	46	194	Large amount of fungi.
33	Beef	Fig. 2, diameter of tube, 1cm.	Animal charcoal, 10° to 15°.	10	Prepared, **Mar. 7,** 1881; put in cultivating chamber, Mar. 7; removed from cultivating chamber, Mar. 18; aspirated at rate of 7 liters per diem, Apr. 12, 13, 15–17, 19–24, 25, 27; May 6; June 23–26, 28–30; July 1, 2, 7–15. Decomposed, **Aug. 2,** 1881.	30	210	Fungus.
34	Beef	Fig. 2, diameter of tube, 1cm.	Loess.....	10	Prepared, **Jan. 13,** 1881; put in cultivating chamber, Feb. 22; removed from cultivating chamber, Mar. 1; aspirated *at rate of* 7 *liters per diem*, Apr. 12, 13, 15–17, 19–24, 26, 27. Decomposed, **Apr. 27,** 1881.	12	84	Filamentary fungi.

QUANTITATIVE AIR-FILTRATIONS.

Slow filtrations through unsterilized filters.

No.	Infusion.	Apparatus.	Filter.		Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
			Kind.	Length in centimeters.				
1	Beef.....	Fig. 3*a*, U-tube employed to hold filtering material, 12.5 by 1cm.	Unsterilized sand, 100°, introduced May 3.	10	Prepared, **Apr. 25**; put in cultivating chamber, Apr. 25; removed from cultivating chamber, May 2; filter introduced, May 3; aspirated at rate of 7 liters per diem, May 3–11, 23–31; June 1–15. **Not decomposed.**	33	231	**Not decomposed.**
2			Unsterilized sand, 30° to 50°, introduced May 3.					
3			Unsterilized gravel, 18° to 20°, introduced May 3.					
4			Unsterilized gravel, 5° to 6°, introduced May 3.	10	Prepared, **Apr. 25**; put in cultivating chamber, Apr. 25; removed from cultivating chamber, May 2; filter introduced, May 3; aspirated, May 3–11. Decomposed between May 12 and May 22.	9	63	Filamentary fungus.

QUANTITATIVE AIR-FILTRATIONS.

Slow filtrations through filters moistened with sterilized water.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
1	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Loess.....	10	Boiling distilled water.	Prepared, **Mar. 8**, 1881; put in cultivating chamber, Mar. 9; removed from cultivating chamber, Mar. 18; aspirated, Apr. 12, 13, 15–17, 18–24, 26, 27. Decomposed, **Apr. 29**, 1881.	7 liters per diem.	84	12	Bacteria.
2	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 100°.....	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Mar. 9**, 1881; removed from cultivating chamber, Mar. 18; aspirated, Apr. 12, 13, 15–17, 18–24, 26, 27; May 6.	7 liters per diem.			
						Same, June 26.....	4 liters p. diem			
						Same, June 28–30; July 1, 2, 7–15; Aug. 5–19, 24–26; Sept. 4, 7–9, 12–15, 21–23; Oct. 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22; Jan. (188) 25–31; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15, 1882. **Not decomposed.**	7 liters per diem.	1691	242	**Not decomposed.**
3	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 50° to 100°	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Apr. 4**, 1881; removed from cultivating chamber, Apr. 12; aspirated, Apr. 12–29.	4, 2, or 7 liters per diem.			
						Same, May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–19, 24–26; Sept. 4, 7–9, 12–15, 21–23; Oct. 4–7, 11–15. Decomposed, **Oct. 16**, 1881.	7 liters per diem.	466	74	Minute fungus.
4	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 10° to 100°	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Apr. 4**, 1881; removed from cultivating chamber, Apr. 12; aspirated, Apr. 12–29.	4, 2, 7 liters per diem.			
						Same, May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–19, 24–26; Sept. 4, 7–9, 12–15, 21–23; Oct. 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22; Jan. (1882) 5–25. Decomposed, **Jan. 26**, 1882.	7 liters per diem.	905	137	

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations through filters moistened with sterilized water—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
5	Beef	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 30° to 50° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Mar. 9,** 1881; removed from cultivating chamber, Mar. 18; aspirated, Apr. 12–29.	4, 2, or 7 liters per diem.	1691	249	**Not decomposed.**
						Same, May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–19, 24–26; Sept. 4, 7–9, 12–15, 21–23; Oct 4–7, 11–27; Nov. 11–17, 22–30; Dec. 1–3, 12–22; Jan. (1882), 5–31; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15. **Not decomposed.**	7 liters per diem.			
6	Beef	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 25° to 30° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Mar. 9,** 1881; removed from cultivating chamber, Mar. 18; aspirated, Apr. 12–29.	4, 2, or 7 liters per diem.	298	50	Fungus.
						Same, May 6; June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–18. Decomposed, **Aug. 19,** 1881.	7 liters per diem.			
7	Beef	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 20° to 25° .	10	Boiling distilled water.	Prepared three times and decomposed three times without aspiration, between Mar. 9 and Mar. 23.		305	51	Fungus.
						Prepared for the fourth time and put in cultivating chamber, **Mar. 23,** 1881; removed from cultivating chamber, Mar. 29; aspirated, Apr. 12–29.	4, 2, or 7 liters per diem.			
						Same, May 6; June 23–26, 28–30, July 1, 2, 7–15; Aug. 5–19. Decomposed **Aug. 24,** 1881.	7 liters per diem.			
8	Beef	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 18° to 20° .	10	Boiling distilled water.	Prepared and put in cultivating chamber. **Oct. 18,** 1881; removed from cultivating chamber, Oct. 25; aspirated, Nov. 15–17, 22–30; Dec. 1–3, 12–22; Jan. (1882), 5–31; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15. **Not decomposed.**	7 liters per diem.	1106	158	**Not decomposed.**

9	Beef.....	Fig. 3a, U-tube, 12.5 by 1cm.	Sand, 16° to 18° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Oct. 19,** 1881; removed from cultivating chamber, Oct. 26; aspirated, Nov. 15–17, 22–30; Dec. 1–3, 12–22; Jan. (1882), 5–31; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–15. **Not decomposed.**	7 liters per diem.	1106	158	**Not decomposed.**
10	Beef.....	Fig. 3a, U-tube, 12.5 by 1cm.	Sand, 14° to 16° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Oct. 22,** 1881; removed from cultivating chamber, Nov. 11; aspirated, Nov. 15–17, 22–30; Dec. 1–3, 12–22; Jan. (1882), 5–31; Feb. 1–24, 28; Mar. 1–21; Apr. 5–30; May 1–11, 23–31; June 1–6. Decomposed, **June 7,** 1882.	7 liters per diem.	1043	149	Bacteria in patches on bottom of flask.
11	Beef.....	Fig. 3a, U-tube, 12.5 by 1cm.	Sand, 12° to 14° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Oct. 25,** 1881; removed from cultivating chamber, Nov. 15; aspirated, Nov. 15–17, 22–30; Dec. 1–3, 12–22; Jan. (1882). 5–10. Decomposed, **Jan. 11,** 1882.	7 liters per diem.	217	31	Fungus.
12	Beef.....	Fig. 3a, U-tube, 12.5 by 1cm.	Sand, 10° to 12° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Oct. 26,** 1881; removed from cultivating chamber, Nov. 15; aspirated, Nov. 15–17, 22–30; Dec. 1–3, 12–22; Jan. (1882), 5–31; Feb. 1–24, 28; Mar. 1–14. Decomposed, **Mar. 15,** 1882.	7 liters per diem.	630	90	Bacterial deposits.
13	Beef.....	Fig. 3a, U-tube, 12.5 by 1cm.	Sand, 9° to 10° ..	10	Boiling distilled water.	Prepared and put in cult. chamber, **Dec. 3,** 1881; removed from cultiv'g chamber, Dec. 12; aspirated, Dec. 12–22; Jan. (1882), 5–31; Feb. 1–24, 28; Mar. 1–21; Apr. 5–15. Decomposed, **Apr. 16,** 1882.	7 liters per diem.	658	94	Bacteria in patches and streaks on walls of flask.
14	Beef.....	Fig. 3a, U-tube, 12.5 by 1cm.	Sand, 8° to 9° ...	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Apr. 19,** 1882; removed from cultiv'g chamber, Apr. 27; aspirated, Apr. 27–30; May 1–11.	7 liters per diem.	105	15	Apparent decomposition on May 22. Kept in cult. chamber until May 25, and then the bacteria disappearing on shaking flask, aspiration was resumed May 25–31.
						Decomposed, **June 1,** 1882	.....	154	22	Contained bacteria in streaks.
15	Beef.....	Flask and infusion of No. 16, the tube of which was broken, as recorded below, was employed.	Sand, 7° to 8° ...	10	Boiling distilled water.	Prepared, **Jan. 23,** 1882; put in cultivating chamber, Jan. 24; removed from cultiv'g chamber, Jan. 31; filter saturated, Feb. 9; aspirated, Feb. 9–24, 28; Mar. 1–7; decomposed, **Mar. 8,** 1882.	7 liters per diem.	171	25	Cloudy.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations through filters moistened with sterilized water—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
16	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 7° to 8° ...	10	Condensed steam; and at beginning of aspiration sterilized water.	Prepared, **Dec. 22,** 1881; put in cultivating chamber, Dec. 23; removed from cultivating chamber, ——— —; filter saturated, Jan. 15–21; tube broke, Jan. 22, 1882.	.....	49	7	Accidental breakage.
17	Beef.....	Fig, 3*a*, U-tube, 12.5 by 1.9^{cm}.	Sand, 6° to 7° ...	10	Boiling sterilized water.	Prepared, **Jan. 21,** 1882; put in cultivating chamber, Jan. 24; removed from cultivating chamber, Jan. 31; filter saturated, Feb. 9; aspirated, Feb. 9–18. Decomposed, **Feb. 19,** 1882.	7 liters per diem.	70	10	Filamentary fungi.
18	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9^{cm}.	Gravel, 5° to 6° .	10	Boiling sterilized water.	Prepared and put in cultivating chamber, **Feb. 17,** 1882; removed from cultivating chamber, Feb. 25; filter saturated, Mar. 1; aspirated, Mar. 1–17. Decomposed, **Mar. 18,** 1882.	7 liters per diem.	119	17	Bacteria.
19	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9^{cm}.	Gravel, 4° to 5° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Feb. 21,** 1882; removed from cultivating chamber, Feb. 28; filter saturated, Mar. 1; aspirated, Mar. 1–21. Decomposed, between **Mar. 22** and **Apr. 4,** 1882.	7 liters per diem.	147	21	Filamentary fungi.
20	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9^{cm}.	Gravel, 3° to 4° .	10	Boiling distilled water.	Prepared and put in cultivating chamber, **Mar. 2,** 1882; removed from cultivating chamber, Mar. 10; filter saturated, Mar. 10; aspirated, Mar. 10–21. Decomposed, between **Mar. 22** and **Apr. 4,** 1882.	7 liters per diem.	84	12	Fungus.

QUANTITATIVE AIR-FILTRATIONS.

Slow filtration through filters moistened with unsterilized water.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
1	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 10° to 100°	10	Unsterilized water	Prepared and put in cultivating chamber, **Apr. 7**, 1881; removed from cultivating chamber, Apr. 14; filter saturated, Apr. 14; aspirated, Apr. 15–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–19, 24–26; Sept. 4, 7–9, 12–15. Decomposed, **Sept. 21**, 1881.	Apr. 15–29, 4, 2, or 7 liters per diem. May 6 to Sept. 15, 7 liters per diem.	382	62	Fungus.
2	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 30° to 50°.	10	Unsterilized water	Prepared and put in cultivating chamber, **Apr. 22**,1882; removed from cultivating chamber, ——; filter saturated, Apr. 30; aspirated, Apr. 30; May 1–11, 22–31; June 1–15. **Not decomposed.**	7 liters per diem.	262	36	**Not decomposed.**
3	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Gravel, 18° to 20°	10	Unsterilized water	Prepared and put in cultivating chamber, **Apr. 22**,1882; removed from cultivating chamber, ——; filter saturated, Apr. 27; aspirated, Apr. 28–30; May 1–11, 22–31; June 1–15. **Not decomposed.**	7 liters per diem.	252	36	**Not decomposed.**
4	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Gravel, 8° to 9°.	10	At first saturated with condensed vapor, but when aspiration began unsterilized water was added.	Prepared, **Dec. 20**, 1881; put in cultivating chamber, Dec. 23; removed from cultivating chamber, —— —; aspirated, Jan. 6–13. Decomposed, **Jan. 14**, 1882.	7 liters per diem.	63	9	Cloudy. This is the first instance of the decomposition of wet gravel filter in advance of the *dry*, and is probably due to the use of *un*sterilized water in filter.

QUANTITATIVE AIR-FILTRATIONS.

Slow filtration at temperature of laboratory through filters moistened with putrescible liquids.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
1	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Loess.....	10	Sewage and urine.	Prepared twice and decomposed twice without aspiration between Mar. 19 to Mar. 23. Prepared for the third time and put in cultivating chamber, **Mar. 23**, 1881; removed from cultivating chamber, Mar. 29; filter saturated for first time, Apr. 12; aspirated, Apr. 12–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1, 2, 7, 8. Decomposed, **July 8**, 1881.	Apr. 12–29, 4, 2, or 7 liters per diem. May 6 to July 8, 7 liters per diem.	144	28	Bacteria.
2	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 100°.....	10	Sewage and urine. Putrid blood and diarrhœal fæces used also in resaturation of filter.	Prepared and put in cultivating chamber, **Mar. 19**, 1881; removed from cultivating chamber, Mar. 29; filter saturated for first time, Apr. 12; aspirated, Apr. 12–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–10; filter resaturated, Aug. 11; aspirated, Aug. 11–19, 24–26; Sept. 4, 7–9, 12–15; filter resaturated, Sept. 15; aspirated, Sept. 21–23; Oct. 4–7, 11–21; filter resaturated, Oct. 22; aspirated, Oct. 22–27; Nov. 11–17, 22–30; Dec. 1; filter resaturated, Dec. 2; aspirated, Dec. 2, 3, 12–22; Jan. (1882) 5–13; filter resaturated, Jan. 14; aspirated, Jan. 14–31; Feb. 1–8; filter resaturated, Feb. 9; aspirated, Feb. 9–24, 28; Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2–21; Apr. 5–28; filter resatu-	Apr. 12–29, 4, 2, or 7 liters per diem. May 6, 1881, to June 15, 1882, 7 liters per diem.	1,691	249	**Not decomposed.**

						rated, Apr. 29; aspirated, Apr. 29, 30; May 1–11; 23–31; June 1–15. **Not decomposed.**				
3	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 50° to 100°	10	Sewage and urine.	Prepared and put in cultivating chamber, **Apr. 7**, 1881; removed from cultivating chamber, Apr. 14; filter saturated (first time), Apr. 14; aspirated, Apr. 14–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1. Decomposed, **July 1,** 1881.	Apr. 14–29, 4, 2, or 7 liters per diem. May 6 to July 1, 7 liters per diem.	123	25	Bacteria.
4	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 10° to 100°	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Apr. 20,**1882; removed from cultivating chamber, Apr. 27; filter saturated, Apr. 28; aspirated, Apr. 28–30; May 1–11, 22–31; June 1–15. **Not decomposed.**	7 liters per diem.	266	38	**Not decomposed.**
5	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 30° to 50°.	10	Sewage and urine.	Prepared and put in cultivating chamber, **Mar. 21,**1881; removed from cultivating chamber, Mar. 29; filter saturated (first time), Apr. 12; aspirated, Apr. 12–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–10; filter resaturated, Aug. 11; aspirated, Aug. 11–19, 24–26; Sept. 4, 7–9, 12–15; filter resaturated, Sept. 15; aspirated, Sept. 21, 22; experiment interrupted by accident at this point, Sept. 22, 1881.	Apr. 12–29, 4, 2, or 7 liters per diem. May 6 to Sept. 22, 7 liters per diem.	389	.....	Accidental breakage Sept. 22.
6	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}. The tube of No. 5, with its contents, was used again in this experiment.	Sand, 30° to 50°.	10	Sewage and urine. Putrid blood and diarrhœal fæces also used for resaturation.	Prepared and put in cultivating chamber, **Sept. 22,** 1881; removed from cultivating chamber, Oct. 4; filter resaturated, Oct. 4; aspirated, Oct. 11–22; filter resaturated, Oct. 22; aspirated, Oct. 23–27; Nov. 11–17, 22–30; Dec. 1, 2; filter resaturated, Dec. 2; aspirated, Dec. 3, 12–15; Dec. 16, filter-tube found stopped by separation of salts from the infusion; was removed, and then stopped and broken off by means of sterilized forceps; the tube, after passing the filter	7 liters per diem.	861	123	Filamentous fungi.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtration at temperature of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
6	Experiment No. 6—Continued.					through a flame, was reinserted; the flask had been kept during the process under a funnel by the side of a gas-jet; aspirated, Dec. 17–21; filter resaturated, Dec. 20; aspirated, Dec. 21, 22; Jan. (1882) 5–10; filter resaturated, Jan. 10; aspirated, Jan. 11–17; filter resatur'd, Jan. 17; aspirated, Jan. 18–29; filter resaturated, Jan. 29; aspirated, Jan. 30, 31; Feb. 1, 2; filter resaturated, Feb. 3; aspirated, Feb. 3–8; filter resaturated, Feb. 9; aspirated, Feb. 11–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, Feb. 23; aspirated, Feb. 23, 24, 28; Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2–6; filter resaturated, Mar. 7; aspirated, Mar. 7–12; filter resaturated, Mar. 13; aspirated, Mar. 13–21. Decomposed, between **Mar. 22** and **Apr. 4**, 1882.				
7	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 25° to 30°.	10	Sewage and urine.	Prepared and put in cultivating chamber, **Mar. 21**, 1881; removed from cultivating chamber, Mar. 29; filter saturated (first time) Apr. 12; aspirated, Apr. 12–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–10; filter resaturated, Aug. 11; aspirated, Aug. 11–19, 24–26; Sept. 4, 7–9, 12–15; filter resaturated, Sept. 15; aspirated, Sept. 21–23; Oct. 4–7,	Apr. 12–29, 4, 2, or 7 liters per diem. May 6 to Oct. 27, 7 liters per diem.	550	86	Bacteria.

						11–21; filter resaturated, Oct. 22; aspirated, Oct. 22–27. Decomposed, **Nov. 11,** 1881.				
8	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 20° to 25°.	10	Sewage and urine.	Prepared and put in cultivating chamber, **Mar. 21,** 1881; removed from cultivating chamber, Mar. 29; filter saturated (first time), Apr. 12; aspirated, Apr. 12–29; May 6; filter resaturated, June 21; aspirated, June 23–26, 28–30; July 1, 2, 7–15; Aug. 5–10; filter resaturated, Aug. 11; aspirated, Aug. 11–19, 24–26; Sept. 4, 7–9, 12–15; filter resaturated, Sept. 15; aspirated, Sept. 21–23. Decomposed, **Oct. 4,** 1881.	Apr. 12–29, 4, 2, or 7 liters per diem. May 6 to Sept. 22, 7 liters per diem.	403	65	Fungus.
9	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 18° to 20°.	10	Sewage and urine. Putrid blood and diarrhœal fæces also sometimes used for resaturation.	Prepared and put in cultivating chamber, **Oct. 18,** 1881; removed from cultivating chamber, Oct. 25; filter saturated (first time), Nov. 15; aspirated, Nov. 16, 17, 25–28; filter resaturated, Nov. 29; aspirated, Nov. 29, 30; Dec. 1; filter resaturated, Dec. 2; aspirated, Dec. 2, 3, 12–19; filter resaturated, Dec. 20; aspirated, Dec. 20, 21, 22; end of filter-tube, which was choked by crystals, was broken as in experiment No. 6; flask treated as in that experiment, and aspiration continued Jan. (1882) 6–9; filter resaturated, Jan. 10; aspirated, Jan. 10–16; filter resaturated, Jan. 17; aspirated, Jan. 17–28; filter resaturated, Jan. 29; aspirated, Jan. 29–31; Feb. 1, 2; filter resaturated, Feb. 3; aspirated, Feb. 3–8; filter resaturated, Feb. 9; aspirated, Feb. 9–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, Feb. 23; aspirated, Feb. 23, 24, 28; Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2–6; filter resaturated, Mar. 7; aspirated, Mar. 7–12; filter resaturated, Mar. 13; aspirated, Mar. 13–21. Decomposed, between **Mar. 22** and **Apr. 4,** 1882.	7 liters per diem.	672	96	Slightly cloudy from bacteria.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtration at temperature of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
10	Beef.....	Fig. 3*a*, U-tube, 12-5 by 1cm.	Sand, 16° to 18°.	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Oct. 19,** 1881; removed from cultivating chamber, Oct. 26; filter saturated, Nov. 15; aspirated, Nov. 16, 17, 22–28; filter resaturated, Nov. 29; aspirated, Nov. 29, 30; Dec. 1; filter resaturated, Dec. 2; aspirated, Dec. 2, 3, 12–17; end of filter-tube, which was choked by crystals, was broken off; apparatus treated as in case of No. 6; filter resaturated, Dec. 20; aspirated, Dec. 20, 21, 22; Jan. (1882) 5–9; filter resaturated, Jan. 10; aspirated, Jan. 10–16; filter resaturated, Jan. 17; aspirated, Jan. 17–28; filter resaturated, Jan. 29; aspirated, Jan. 29–31; Feb. 1, 2; filter resaturated, Feb. 3; aspirated, Feb. 3–8; filter resaturated, Feb. 9; aspirated, Feb. 9–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, Feb. 23; aspirated, Feb. 23, 24, 28; Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2, 3. Decomposed, **Mar. 4,** 1882.	7 liters per diem.	546	78	Cloudy. On Mar. 2 filter was supersaturated so that bubbling took place during aspiration. Filter was removed at once, heated, and then replaced in flask.
11	Beef.....	Fig. 3*a*, U-tube, 12-5 by 1cm.	Sand, 14° to 16°.	10	Sewage and urine, &c.	Prepared the second time (the first preparation breaking down within 24 hours) and put in cultivating chamber, **Oct. 24,** 1881; removed from cultivating chamber, Nov. 13; filter saturated, Nov. 15; aspirated, Nov. 16, 17, 22–28; filter resaturated, Nov.	7 liters per day.	441	63	Contained two minute fungi.

						29; aspirated, Nov. 29, 30; Dec. 1; filter resaturated, Dec. 2; aspirated, Dec. 2, 3, 12–19; filter resaturated, Dec. 20; aspirated, Dec. 20, 21, 22; end of filter-tube, which was choked by crystals, was broken off, and apparatus treated as in the case of No. 6; aspirated Jan. (1882) 6–9; filter resaturated Jan. 10; aspirated, Jan. 10–16; filter resaturated, Jan. 17; aspirated, Jan. 17–28; filter resaturated, Jan. 29; aspirated, Jan. 29–31; Feb. 1, 2; filter resaturated, Feb. 3; aspirated, Feb. 3–8; filter resaturated, Feb. 9; aspirated, Feb. 9–13. Decomposed, **Feb. 14,** 1882.				
12	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 12° to 14°.	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Oct. 25,** 1881; removed from cultivating chamber, Nov. 15; filter satuated (first time), Nov. 15; aspirated. Nov. 15–17, 22–28; filter resaturated, Nov. 29; aspirated, Nov. 29, 30, Dec. 1; filter resaturated, Dec. 2; aspirated, Dec. 2, 3, 12–19; filter resaturated, Dec. 20; aspirated, Dec. 20–22, Jan. (1882) 5–9; filter resaturated, Jan. 10; aspirated, Jan. 10–13; filter resaturated, Jan. 14; aspirated, Jan. 14–16; filter resaturated, Jan. 17; aspirated, Jan. 17–28. Decomposed, **Jan. 29,** 1882.	7 liters per diem.	343	49	**Fungus.**
13	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 10° to 12°.	10	Sewege and urine, &c.	Prepared and put in cultivating chamber, **Oct. 26,** 1881; removed from cultivating chamber, Nov. 15; filter saturated (first time), Nov. 15; aspirated, Nov. 15–17, 22–28; filter resaturated, Nov. 29; aspirated, Nov. 29, 30, Dec. 1; filter resaturated, Dec. 2; aspirated, Dec. 2, 3. Decomposed, **Dec. 5,** 1881.	7 liters per diem.	98	14	**Supersaturated on Nov. 29, so that filter bubbled for a few moments upon aspirating. Cloudy, and contained fungus.**

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtration at temperature of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
14	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm. Substituted for No. 13, which decomposed in consequence of bubbling.	Sand, 10° to 12°.	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Jan. 28,** 1882; removed from cultivating chamber, Feb. 6; filter saturated, Feb. 9; aspirated, Feb. 9–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, Feb. 23; aspirated, Feb. 23, 24, 28, Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2–5. Decomposed, **Mar. 6,** 1882.	7 liters per diem.	154	22	Fungi.
						The fungus found upon Mar. 6 did not grow; aspiration was therefore resumed. Aspirated, Mar. 15–21, Apr. 5–17; filter resaturated, Apr. 18; aspirated, Apr. 18–30, May 1–11. Decomposed, between **May 12** and **May 22,** 1882.	7 liters per diem.	462	66	Very turbid.
15	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 9° to 10°..	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Dec. 3,** 1881; removed from cultivating chamber, Dec. 12; filter saturated (first time), Dec. 12; aspirated, Dec. 12–19; filter resaturated, Dec. 20; aspirated, Dec. 20–22, Jan. (1882) 5–9; filter resaturated, Jan. 10; aspirated, Jan. 10–13; filter resaturated, Jan. 14; aspirated, Jan. 14–16; filter resaturated, Jan. 17; aspirated, Jan. 17–31. Decomposed, **Feb. 1,** 1882.	7 liters per diem.	266	38	Fungi.

16	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}.	Sand, 8° to 9°...	10	Sewage and urine, &c.	Prepared, **Dec. 21,** 1881; put in cultivating chamber, Dec. 23; removed from cultivating chamber, (?) ; filter saturated (first time), Jan. (1882) 6; aspirated, Jan. 6–9; filter resaturated, Jan. 10; aspirated, Jan. 10–13; filter resaturated, Jan. 14; aspirated, Jan. 14, 15, 16; filter resatuated, Jan. 17; aspirated, Jan. 16–22. Decomposed, **Jan. 23,** 1882.	7 liters per diem.	119	17	Filter supersaturated Jan. 17; bubbling did not begin until afternoon of Jan. 18. Cloudy.
17	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1^{cm}. Filter of No. 16 used again. This experiment to replace No. 16, which ended in consequence of bubbling.	Sand, 8° to 9°...	10	Sewage and urine, &c.	Prepared, **Jan. 23,** 1882; put in cultivating chamber, Jan. 24; removed from cultivating chamber, Jan. 31; filter saturated, Feb. 9; aspirated Feb. 9–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, Feb. 23; aspirated, Feb. 23, 24. Decomposed, **Feb. 27,** 1882.	7 liters per diem.	112	16	Filamentary fungi.
18	Beef.....	.....	Sand, 7° to 8°...	19	Sewage and urine, &c.	Prepared, **Dec. 22,** 1881; put in cultivating chamber, Dec. 23; removed from cultivating chamber, (?) ; filter saturated, Jan. (1882) 15; aspirated, Jan. 15–16; filter resaturated, Jan. 17; aspirated, Jan. 17–31. Decomposed, **Feb. 1,** 1882.	7 liters per diem.	119	17	Fungi.
19	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9^{cm}.	Sand, 6° to 7°...	10	Sewage and urine, &c.	Prepared, **Jan. 21,** 1882; put in cultivating chamber, Jan. 24; removed from cultivating chamber, Jan. 31; filter satuated, Feb. 9; aspirated, Feb. 9–15; filter saturated, Feb. 16; aspirated, Feb. 16–22; filter saturated, Feb. 23; aspirated, Feb. 23, 24, 28, Mar. 1; filter saturated, Mar. 2; aspirated, Mar. 2–6; filter saturated, Mar. 7; aspirated, Mar. 7–12. Decomposed, **Mar. 13,** 1882.	7 liters per diem.	203	29	Filamentary fungi.
20	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9^{cm}.	Gravel, 5° to 6°.	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Feb. 17,** 1882; removed from cultivating chamber, Feb. 25; filter saturated (first time), Mar. 1; aspirated, Mar. 1–4. Decomposed, **Mar. 5,** 1882.	7 liters per diem.	32	5	Filamentary fungi.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtration at temperature of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
21	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9cm.	Gravel, 4° to 5°	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Feb. 21,** 1882; removed from cultivating chamber, Feb. 28; filter saturated (first time), Mar. 1; aspirated, Mar. 1–6; filter resaturated, Mar. 7; aspirated, Mar. 7–12; filter resaturated, Mar. 13; aspirated, Mar. 13–21, Apr. 5–17; filter resaturated, Apr. 18; aspirated, Apr. 18–30, May 1–10. Decomposed, **May 11,** 1882.	7 liters per diem.	399	57	Small fungus.
22	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1.9cm.	Gravel, 3° to 4°	10	Sewage and urine, &c.	Prepared and put in cultivating chamber, **Mar. 2,** 1882; removed from cultivating chamber, Mar. 10; filter saturated, Mar. 10; aspirated, Mar. 10–19. Decomposed, **Mar. 20,** 1882.	7 liters per diem.	70	10	Filamentary fungi.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations at temperatures above that of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
						Treated in hood, at temperatures varying from the ordinary temperature of laboratory to about 66° C. See table of temperatures.				
1	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 100°.....	10	Sewage and urine. Putrid beef juice, putrid blood, diarrhœal and dysenteric fæces diluted with water, were also used in some of the resaturations.	Prepared and put in cultivating chamber, Aug. 19, 1881; removed from cultiv'g chamber, Sept. 6; filter saturated (first time), Sept. 6; aspirated, Sept. 6–9, 12–15: filter resaturated, Sept. 16; aspirated, Sept. 21–23; filter resaturated Oct. 4; aspirated, Oct. 4–7, 11–15; filter resaturated, Oct. 16; aspirated, Oct. 16–22; filter resaturated, Oct. 22; aspirated, Oct. 23–27; filter resaturated, Oct. 27; filter resaturated, Nov. 11; aspirated, Nov. 11–16; filter resaturated, Nov. 17; aspirated, Nov. 17, 22–24; filter resaturated, Nov. 24; aspirated, Nov. 25–29; filter resaturated, Nov. 29; aspirated, Nov. 30; Dec. 1, 2; filter resaturated, Dec. 2; aspirated, Dec. 3, 4, 12–14, 16, 17; filter resaturated, Dec. 17; aspirated, Dec. 18, 19, 20; filter resaturated, Dec. 20; aspirated, Dec. 21, 22; filter resaturated, Jan. 5, 1882; aspirated, Jan. 6–13; filter resaturated, Jan. 14; aspirated, Jan. 14–16; filter resaturated, Jan. 17; aspirated, Jan. 17–23; filter resaturated, Jan. 24; aspirated, Jan. 24–29; filter resaturated, Jan. 29; aspirated, Jan. 30, 31; Feb. 1–8; filter resaturated, Feb.	Generally 4 liters per diem. Occasionally 2 liters per diem.	690	188	**Not decomposed.**

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations at temperatures above that of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
1	Experiment No. 1—Continued.....	.....	.....	.....	.....	*Treated in hood, &c.*—Continued. 9; aspirated, Feb. 9–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, Feb. 23; aspirated, Feb. 23, 28; Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2–6; filter resaturated, Mar. 7; aspirated, Mar. 7–12; filter resaturated, Mar 13; aspirated, Mar. 13–21; Apr. 5–13; filter resaturated, Apr. 14; aspirated, Apr. 14–17; filter resaturated, Apr. 18; aspirated, Apr. 18–21; filter resaturated, Apr. 22; aspirated, Apr. 22–30; May 1–11, 25–31; June 1–15.				
2	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 50° to 100°	10	Sewage and urine.	History identical with that of No. 1, excepting that the flask was opened for examination of contents on Oct. 7, 1881. The infusion was alkaline, gave off odor of stale urine, especially on boiling; also ammonia on boiling. After examination the infusion was resterilized, and the experiment continued.	Generally 4 liters per diem. Occasionally 2 liters per diem.	690	188	**Not decomposed.**
3	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 10° to 100°	10	Sewage and urine, &c. See No. 19.	History identical with that of No. 6 (page 628), excepting that aspiration did not begin until Oct. 12, was omitted Feb. 10, 1882, and that there was no bubbling of filter on Feb. 23, 1882. **Not decomposed.**	Generally 4 liters per diem. Occasionally 2 liters per diem.	650	171	**Not decomposed.**

4	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 30° to 50° .	10	Sewage and urine	Prepared and put in cultivating chamber Aug. 19, 1881; removed from cultivating chamber, Sept. 6; filter saturated (first time), Sept. 6; aspirated, Sept. 6–9, 12–15; filter resaturated, Sept. 16; aspirated, Sept. 21–23; filter resaturated. Oct. 4; aspirated, Oct. 4–7. Opened on Oct. 7. Infusion was alkaline, gave off odor of stale urine, especially on boiling; also ammonia on boiling. The filter was changed to the flask of No. 5, and after sterilizing the infusion, the experiment was continued. This change was made for the sake of keeping the original infusion of No. 4 for the microscopic examination of the deposit (chemical) found in it. Aspirated, Oct. 11–15; filter resaturated, Oct. 16; aspirated, Oct. 16–22; filter resaturated, Oct. 22; aspirated, Oct. 23–27; filter resaturated, Oct. 27; filter resaturated, Nov. 11; aspirated, Nov. 11, 12. Decomposed, Nov. 13, 1881.	Generally 4 liters per diem. Occasionally 2 liters per diem.	128	33	Bacteria.
5	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 25° to 30° .	10	Sewage and urine.	Prepared and put in cultivating chamber, Aug. 19, 1881; removed from cultivating chamber, Sept. 6; filter saturated (first time), Sept. 6; aspirated, Sept. 6–9, 12–15; filter resaturated, Sept. 16; aspirated, Sept. 21–23; filter resaturated, Oct. 4; aspirated, Oct. 4–7. Opened Oct. 7. Infusion was alkaline; gave off odor of stale urine, especially on boiling, and ammonia on boiling. Experiment discontinued, Oct. 7, 1881.	Generally 4 liters per diem. Occasionally 2 liters per diem.	56	15	Experiment discontinued.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtrations at temperatures above that of laboratory through filters moistened with putrescible liquids—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.	Liquid.					
						Treated in hood, &c.—Continued.				
6	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Sand, 20° to 25° .	10	Sewage and urine. Putrid beef juice, putrid blood, diarrhœal and dysenteric fæces diluted with water, were sometimes used for resaturation.	Prepared and put in cultivating chamber, Aug. 26, 1881; removed from cultivating chamber, Sept. 8; filter saturated (first time), Oct. 7; aspirated, Oct. 7, 11–15; filter resaturated, Oct. 15; aspirated Oct. 16–22; filter resaturated, Oct. 22; aspirated, Oct. 23–27; filter resaturated, Oct. 27; filter resaturated, Nov. 11; aspirated, Nov. 11–16; filter resaturated, Nov. 17; aspirated, Nov. 17, 22–24; filter resaturated, Nov. 24; aspirated, Nov. 25–29; filter resaturated, Nov. 29; aspirated, Nov. 30, Dec. 1, 2; filter resaturated, Dec. 2; aspirated, Dec. 3, 4, 12–14, 16, 17; filter resaturated, Dec. 17; aspirated, Dec. 18, 19, 20; filter resaturated, Dec. 20; aspirated, Dec. 21, 22; filter resaturated, Jan. 5, 1882; aspirated Jan. 6–13; filter resaturated, Jan 14; aspirated, Jan. 14–16; filter resaturated, Jan. 17; aspirated, Jan. 17–23; filter resaturated, Jan. 24; aspirated, Jan. 24–29; filter resaturated, Jan. 29; aspirated, Jan. 30, 31; Feb. 1–8; filter resaturated, Feb. 9; aspirated, Feb. 9–15; filter resaturated, Feb. 16; aspirated, Feb. 16–22; filter resaturated, supersaturated, and bubbled in consequence. Feb,	Generally 4 liters per diem. Occasionally 2 liters per diem.	660	174	**Not decomposed.**

					23; aspirated, Feb. 23, 28; Mar. 1; filter resaturated, Mar. 2; aspirated, Mar. 2–6; filter resaturated, Mar. 7; aspirated, Mar. 7–12; filter resaturated, Mar. 13; aspirated, Mar. 13–21; Apr. 5–13; filter resaturated, Apr. 14; aspirated, Apr. 14–17; filter resaturated, Apr. 18; aspirated, Apr. 18–21; filter resaturated, Apr. 22; aspirated, Apr. 22–30; May 1–11, 25–31; June 1–15. **Not decomposed.**				

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtration through open tubes, with disk of gauze.

No.	Infusion.	Apparatus.	Filter.		Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
			Kind.	Length in centimeters.				
1	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 80°.	.....	Prepared, **Nov. 26,** 1881; put in hood, Nov. 26; removed from hood, Dec. 3; aspirated, Dec. 12 and 13 (250 cm3 during 10 hours); 14 and and 15 (850 cm3). Decomposed, **Jan. 10,** 1882.	4	$1\frac{1}{10}$	Fungi.
2	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 25°.	.....	Prepared, **Jan. 18,** 1882; put in cultivating chamber, Jan. 18; removed, Jan. 5; aspirated at rate of 7 liters per diem, Jan. 5–29; decomposed, **Jan. 30,** 1882.	4	28	Fungi and cloudiness.
3	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 80°.	.....	Prepared, **Jan. 23,** 1882; put in cultivating chamber, Jan. 24; removed from cultivating chamber, Jan. 30; aspirated at rate of 7 liters per diem, Feb. 9–13; decomposed, **Feb. 14,** 1882.	5	35	Several filamentary fungi.
4	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 25°.	.....	Prepared, **Feb. 18,** 1882; put in cultivating chamber, Feb. 18; removed from cultivating chamber, Feb. 25; aspirated at rate of 7 liters per diem, Mar. 3–8; decomposed, **Mar. 9,** 1882.	6	42	Filamentary fungi (small).
5	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 25°.	.....	Prepared, **Feb. 21,** 1882; put in cultivating chamber, Feb. 21; removed from cultivating chamber, Feb. 28; aspirated at rate of 7 liters per diem, Mar. 6–8; decomposed, **Mar. 9,** 1882.	7	25	Filamentary fungi.
6	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 25°.	.....	Prepared, **Feb. 24,** 1882; put in cultivating chamber, Feb. 24; removed from cultivating chamber, Mar. 3; aspirated at rate of 7 liters per diem, Mar. 10–16; decomposed, **Mar. 17,** 1882.	7	49	Filamentary fungi.
7	Beef.....	Fig. 2, tube 12.5 by 1.9cm.	Open tube, copper gauze, 25°.	.....	Prepared, **Mar. 3,** 1882; put in cultivating chamber, Mar. 3; removed from cultivating chamber, Mar. 11; aspirated at rate of 7 liters per diem, Apr. 6–11; decomposed, **Apr. 12,** 1882.	6	42	Filamentary fungus.
8	Beef.....	Fig. 2, diameter of tube, 1cm.	Open tube, copper gauze, 25°.	.....	Prepared, **Apr. 13,** 1882; put in cultivating chamber, Apr. 13, removed from cultivating chamber, Apr. 20; aspirated at rate of 7 liters per diem, Apr. 24–26; decomposed, **Apr. 27,** 1882.	3	21	Filamentary fungus.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Slow filtration through open tubes, without gauze.

No.	Infusion.	Apparatus.	Filter.		Special treatment.	Rate of aspiration.	Number of liters aspirated.	Number of aspirations.	Remarks upon decomposition.
			Material.	Length in centimeters.					
1	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put under hood, **Nov. 26,** 1881; removed from under hood, Dec. 3; aspirated, Dec. 12; Jan. 8–14; decomposed, **Jan. 15,** 1882.	Dec. 12, 0.960 in 4 hours. Jan. 8–14, 7 liters per diem.	50	8	Contained a very minute fungus.
2	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put in cultivating chamber, **Dec. 3,** 1881; removed from cultivating chamber, Dec. 12; aspirated, Dec. 15; decomposed, **Dec. 19,** 1881.	7 liters per diem.	7	1	Cloudy.
3	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared, **Jan. 23,** 1882; put in cultivating chamber, Jan. 24; removed from cultivating chamber, Jan. 31; aspirated, Feb. 15–23; decomposed, **Feb. 24,** 1882.	7 liters per diem.	66	10	Fungoid growth.
4	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put in cultivating chamber, **Feb. 24,** 1882; removed from cultivating chamber, Mar. 3; aspirated, Mar. 4–9; decomposed, **Mar. 10,** 1882.	7 liters per diem.	42	6	Filamentary fungi.
5	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put in cultivating chamber, **Feb. 24,** 1882; removed from cultivating chamber, Mar. 3; aspirated, Mar. 6–9; decomposed, **Mar. 10,** 1882.	7 liters per diem.	31	5	Numerous filamentary fungi.
6	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put in cultivating chamber, **Mar. 3,** 1882; removed from cultivating chamber, Mar. 11; aspirated, Mar. 11–20; decomposed, **Mar. 21,** 1882.	7 liters per diem.	70	10	Filamentary fungus.
7	Beef.....	Fig, 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put in cultivating chamber, **Mar. 3,** 1882; removed from cultivating chamber, Mar. 11; aspirated, Apr. 6–11; decomposed, **Apr. 12,** 1882.	7 liters per diem.	45	7	Minute filamentary fungus.
8	Beef.....	Fig. 3*a*, U-tube, 12.5 by 1cm.	Open tube	.....	Prepared and put in cultivating chamber, **Apr. 13,** 1882; removed from cultivating chamber, Apr. 20; aspirated; Apr. 28–30; May 1, 2; decomposed, **May 3,** 1882.	7 liters per diem.	38	6	Cloudy.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Rapid filtrations through dry sterilized filters.

[Nos. 1 to 24 appeared in former bulletin. Filtrations of air, at intervals, beginning at rates of 1 *liter* in 3 to 7½ *hours*, and increasing to rates of 1 *liter* per 2½ to 1½ *minutes*.]

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—	
			Kind.	Length in centimeters.					Days.	Hours.
1*a*	Beef	U-tubes, 32 by 1.3cm, inner diameter. (See Fig. 3.)	Asbestus	17	June 19	For dates and rates of filtration, see pages 604–608.	1*a*	July 22	10 *from time of saturation.*	
2							2			
3*b*			Sand, 25° to 30°	11			3*b*	June 23	4*b*	
4				6			4			
5			Sand, 100°	11			5			
6				6			6			
7	Hay	U-tubes, Nos. 7, 9, and 11, 46 by 1.3cm, inner diameter; Nos. 8, 10, and 12, 32 by 1.9cm.	Asbestus (packed)	24	July 1	do	7			
8*c*				10			8*c*	July 7	6*c*	
9			Sand, 30° to 50°	24			9			
10				10			10			
11			Sand, 100°	23			11			
12				9			12			
13	Fish	U-tubes, Nos. 13, 15, and 17, 46 by 1.3cm; Nos. 14, 16, and 18, 32 by 1.9cm.	Asbestus (packed)	25	July 15	do	13			
14*d*				10			14*d*	July 19	4*d*	
15			Sand, 30° to 50°	25			15			
16				10			16			
17			Sand, 100°	25			17			
18				10			18			
19	Cucumber	U-tubes, 32 by 1.9cm	Asbestus (packed)	10	July 23	do	19			
20			Sand, 30° to 50°				20			
21			Sand, 100°				21			
22	Beet	U-tubes, 32 by 1.9cm	Asbestus (packed)	10	July 23	do	22			
23			Sand, 30° to 50°				23			
24			Sand, 100°				24			

a The tubes were found to be too narrow for rapid filtrations as the bubbles did not break readily. In No. 1 bubbles were carried up into the filter July 12, moistening it throughout with the infusion. The infusion decomposed at the surface, and decomposition spread downwards, infecting the infusion in the tube.

b Infusion probably not completely sterilized.

c No. 8 was probably not sterilized when filled. The infusion was boiled again in the tube July 17 to destroy the living organisms.

d No. 14 was not sterilized when filled, as it began to break down before being tested as a filter. The infusion was boiled again in the tube July 21 to destroy the growths.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Rapid filtrations through dry sterilized filters—Continued.

DATES OF FILTRATION.*

No.	Infusion.	Rates of filtrations of two liters of air.																							
		July.																							
		3		7		9		12		14		14		17		20		26		27		29		30	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
8	Hay	15	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	45	.....	.....	.....	.....	2	0
10	Hay	12	0	8	0	4	0	2	0	1	40	1	15	1	15	0	55	0	38	.....	.....	.....	.....	0	30
12	Hay	12	0	8	0	4	30	1	50	1	40	1	15	1	15	0	50	0	45	.....	.....	.....	.....	0	30
14	Fish	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	0	.....	.....	0	35
16	Fish	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	30	.....	.....	2	30	.....	.....	2	0
18	Fish	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	30	.....	.....	2	30	.....	.....	2	0
19	Cucumber	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	50	.....	.....
20	Cucumber	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	45	.....	.....
21	Cucumber	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	45	.....	.....
22	Beet	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	50	.....	.....
23	Beet	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	50	.....	.....
24	Beet	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	50	.....	.....

* The filtration of Nos. 1–6, 7, 9, 11, 13, 15, 17 are omitted from this table as *very* rapid filtrations could not be carried on in these narrow (1.3^{cm}) tubes. The filtrations of *two* liters of air ranged from *fifteen hours* to *thirty minutes*. The filtrations of one liter of air ranged from 22 minutes to 11 seconds.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Rapid filtrations through dry sterilized filters—Continued.

DATES OF FILTRATION—Continued.

No.	Infusion.	Rates of filtrations of one liter of air.															
		October.				November.				March.*						April.*	
		25		26		1		29		4		18		29		9	
		M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.
8	Hay	12				6		1	30	1			45		15		13
10		22		4		3		1	30		50		35		18		14
12				11		9½		2		1	20		50		40		40
14	Fish	12				10		2	30	3		1	30		25		20
16																	
18																	
19	Cucumber	9				8		2		1	40	1	10		40		40
20				9		4		1	30		45		40		15		12
21				9		3		2		1	15		40		30		35
22	Beet	13				6		2		1	20	1			30		22
23				10		5		1	30		40		20		10		11
24				9	30	4		2		1	15		50		35		32

* During March and April the filters were sterilized by heating immediately after each aspiration.

QUANTITATIVE AIR-FILTRATIONS—Continued.

Rapid filtrations through dry sterilized filters—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Time, in seconds, of most rapid passage of 10 liters of air.	Date of last aspiration previous to decomposition.	Date of decomposition.	Remarks upon decomposition.
			Kind.	Length in centimeters.	Beginning of experiment.					
25	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 100°....	10	Aug. 10, 1881	Flask put in cultivating chamber after aspiration (for temperature, see page 659) and filter sterilized either after or before aspiration. (For rates and times of aspiration, see table following, page 637.)	240	1882.	1882.	
				1	Shortened Oct. 15, 1881	....do.....	30	.....	.....	
							36	Apr. 21	May 2	Fungi evidently of several days' growth.
26	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 50° to 100°.	10	Aug. 10, 1881	.....do.....	120	.....	.....	
				1	Shortened Oct. 15, 1881	....do.....	35	.....	.....	
				0.5	Shortened Apr. 12, 1882	....do.....	224	.....	.....	
27	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 10° to 100°.	10	Aug. 13, 1881	.....do.....	120	.....	.....	
				1	Shortened Oct. 17, 1881	....do.....	36	Mar. 1	Mar. 3	Very cloudy.
28	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 30° to 50°	10	Aug. 10, 1881	.....do.....	65	.....	.....	
				1	Shortened Oct. 15, 1881	....do.....	100	Jan. 13	Jan. 15	Cloudy.
29	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 25° to 30°	10	Aug. 10, 1881	.....do.....	60	.....	.....	
				1	Shortened Nov. 14, 1881	....do.....	100	Jan. 13 1881.	Jan. 14 1881.	Very cloudy in less than 20 hours.
30	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 20° to 25°	10	Aug. 13, 1881	.....do.....	50	.....	.....	
				1	Shortened Nov. 14, 1881	....do.....	120	Dec. 19	Dec. 20	Cloudy from bacteria.
31	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 18° to 20°	10	Oct. 17, 1881	.....do.....	42	.....	.....	
				1	Shortened Apr. 12, 1882	....do.....	178	.....	.....	

QUANTITATIVE AIR-FILTRATIONS—Continued.

Rapid filtrations through dry sterilized filters—Continued.

No.	Infusion.	Apparatus.	Filter.			Special treatment.	Time, in seconds, of most rapid passage of 10 liters of air.	Date of last aspiration previous to decomposition.	Date of decomposition.	Remarks upon decomposition.
			Kind.	Length in centimeters.	Beginning of experiment.					
32	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 16° to 18°	10	Oct. 18, 1881	Flask put in cultivating chamber after aspiration (for temperature, see page 659) and filter sterilized either after or before aspiration. (For rates and times of aspiration, see table following, page 637.)	40	1882.	1882.	.....
				1	Shortened Apr. 12, 1882	....do	270	Apr. 29	May 8	Bacteria in patches.
33	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 14° to 16°	10	Oct. 21, 1881	.....do	36	.....	.....	
				1	Shortened Apr. 12, 1882	....do	237	May 8	May 8	Very cloudy.
34	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 12° to 14°	10	Oct. 24, 1881	.....do	100	Jan. 27	Feb. 1	Large fungi.
35	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 10° to 12°	10	Oct. 26, 1881	.....do	33	Apr. 21	Apr. 25	Slightly cloudy.
36	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 9° to 10°	10	Dec. 2, 1881	.....do	55	Mar. 18	Between Mar. 22 and Apr. 4	Filamentary fungi (Apr. 4).
37	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 8° to 9°.	10	Dec. 21, 1881	.....do	240	Jan. 27	Feb. 1	Large fungi.
38	Beef.....	Fig. 2*a*, diameter of tube, 1cm.	Sand, 7° to 8°.	10	Dec. 21, 1881	.....do	60	May 8	Between May 12 and May 22	Bacteria in streaks up and down walls of flask (May 22).
39	Beef.....	Fig. 2*a*, tube, 12.5 by 1.9cm.	Sand, 6° to 7°	10	Jan. 18, 1882	.....do	81	May 8	May 9	Very cloudy.

40	Beef.....	Fig. 2*a*, tube, 12.5 by 1.9cm.	Gravel, 5° to 6°	10	Jan. 26, 1882	.... do	240	Feb. 25	Feb. 27	Bacteria.
41	Beef.....	Fig. 2*a*, tube, 12.5 by 1.9cm.	Gravel, 4° to 5°	10	Feb. 20, 1882	.....do	302	Mar. 4	Mar. 5	Bacteria.
42	Beef.....	Fig. 2*a*, tube, 12.5 by 1.9cm.	Gravel, 3° to 4°	10	Feb. 23, 1882	.....do	151	Apr. 29	May 1	Filamentary fungus.

Times, given in seconds, during which 10 *liters of air passed through columns of* 10 *centimeters.*

[Heavy-faced type indicates rate at which filter ceased to be effective.]

No.	1881.											1882.															
	September 7.	September 15.	October 4.	October 5.	October 12.	October 19.	October 27.	November 16.	November 25.	December 13.	December 19.	January 13.	January 20.	January 27.	February 11.	February 18.	February 22.	February 25.	March 1.	March 4.	March 11.	March 18.	April 5.	April 21.	April 29.	May 8.
25	330	240	1,020	1,500 1,800																						
26	495	375	1,020	300	300 120																					
27	420	360	1,020	270	120																					
28	285	270	1,020	100	250 65																					
29	240	240	1,020	90	40	45	60																			
30	300	240	1,020	60	70	42	50																			
31								290	260	195	180	150	120	101	95		77		62		50	42	42			
32								290	245	195	180	150	120	100	85		75		61		47	44	40			
33								290	258	193	180	150	120	102	90		72		60		46	38	36			
34								280	256	220	190	150	115	**100**												
35								290	258	200	175	150	120	100	85	72			58		49	39	34	**33**		
36										300	260	240	207	180	148	130		100		92	77	55				
37												300	272	**240**												
38												300		267	240	207		178		158	135	118	100	82	72	**60**
39														300	267	245		204		177	162	150	132	120	98	**81**
40															300	263		**240**								
41																				**302**						
42																				300	275	242	215	180	**151**	

Times, given in seconds, during which 10 *liters of air passed through columns of* 1 *centimeter.*

[Heavy-face type indicates rate at which filters ceased to be effective.]

Number.	1881.						1882.															
	October 19.	October 27.	November 17.	November 25.	December 13.	December 19.	January 13.	January 20.	January 27.	February 10.	February 18.	February 22.	March 1.	March 11.	March 18.	April 5.	April 21.	April 29.	May 8.	May 24.	June 1.	June 9.
25	.....	360	240	225	130	130	.....	190	150	120	90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	.....	260	240	205	130	120	100	90	90	95 / 75	....	61	50	42	35	45	.....	.....	.....	.....	.....	.....
27	470	480	240	199	150	120	100	70	62	80	.....	43	**36**	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	.....	300	240	198	150	120	**100**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	.....	.....	.....	198	150	120	**100**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	240	200	148	**120**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300	270	240	221	200	178
32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300	**270**	.....	.....	.....	.....
33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300	268	**237**	.....	.....	.....

Times, given in seconds, during which 10 *liters of air passed through column of* 0.5 *centimeter.*

[Heavy-face type indicates rate at which filter ceased to be effective.]

Number.	1882.									
	March 1.	March 11.	March 18.	April 5.	April 21.	April 29.	May 8.	May 24.	June 1.	June 9.
25	75	50	40	30	**36**	.....	.....	.....	.....	.....
26	.....	.....	.....	.....	300	285	270	255	240	224

LIQUID-FILTRATIONS.

Filtrations of putrescible infusions through sterilized filters into sterilized empty tubes.

[Nos. 1 to 54 appeared in former bulletin.]

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks on decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
1	Beef (See notes *a*, *d*.)	Fig. 1, tubes, 46 by 2cm.	Sand, 25° to 40°.	16	June 19	.....	1	June 24	5	.....	
2							2				
3			Sand, 100°				3	July 1	12	.....	
4							4				
5*a*,*b*	Beef	Flask, 250cm3	Sand, 100°.....	45	June 23	.....	5	June 24	1	.....	
6	Beef ..... (See notes *a*, *c*.)	Tubes, 46 by 2cm	Sand, 25° to 40°....	15	June 26	.....	6	June 27	1	.....	
7							7				
8	Beef ..... (See notes *a*, *c*, *d*.)	Tubes, 46 by 2cm	Sand, 25° to 40°....	15	June 28	.....	8	June 30	2	.....	
9							9	June 29	1	.....	
10*c*	Beef	Tube, 46 by 2cm.....	Asbestus (tightly packed).	15	July 9	No. 10 was warmed slightly on the 9th and 10th instants several times to hasten the filtration.	10	July 13	4	.....	

a The infusions were filtered very slowly into all the tubes, but especially into Nos. 1 to 4 and 6 to 9, from one to four days being allowed for the filtration of about two inches of the infusions. Only a very small quantity of the infusion filtered through the fine sands of Nos. 3 and 4, as the tubes were not warmed. As the air of the tubes could only escape by forcing its way up through the mass of the filters, some difficulty was experienced in carrying on the filtrations through the very fine sands and charcoals, the air tending to raise the entire mass of the filters instead of slowly working its way through them in minute bubbles. The charcoal filters were accordingly forcibly pressed down by disks of copper gauze, fitted tightly into the tubes. As the infusions in Nos. 1 to 4 were slightly colored by copper salts, due to action of the infusions upon the copper gauze employed, Ex. 26, page 594, was made to determine whether the copper salts present had any effect in preventing the decompositions. In no cases, however, as was subsequently found, have the copper salts preserved the infusions. The infusions for Nos. 1 to 5 were exposed for several hours in evaporating-dishes to the air of a stable-loft; those for Nos. 25 to 28 were exposed over night in the laboratory, and were diluted with tap-water before the filtrations.

b No. 5 contained a tube 50 by 1.5cm. Tube tightly packed with asbestus in the neck of the flask. The filtration was carried on rapidly.

c The infusions Nos. 6 and 7 were exposed for six hours in evaporating-dishes near old hay in a cellar. Those for Nos. 8 and 9 were exposed nine hours near old hay. Those for Nos. 10 to 24 and Nos. 30 to 38 were exposed in the laboratory over night in evaporating dishes. Those for Nos. 39 to 42 from 9 a. m. until 6 p. m. on the 22d instant in capsules.

d Tubes 8 and 9 were heated on a combustion-furnace at a red heat nearly one hour. Tubes 1 to 4 were heated on a combustion-furnace ten minutes at as high a temperature as the glass would bear without softening.

LIQUID-FILTRATIONS—Continued.

Filtrations of putrescible infusions through sterilized filters into sterilized empty tubes—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks on decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
11	Beef (See note *a*.)	Tubes, 46 by 2cm	**Asbestus (tightly packed).**	15	July 24	Tubes 11 and 12 were gently warmed several times, but the filtration was not carried on so rapidly as in the previous case.	11	1881. Aug. 4	**11**	.....	
12							12	Aug. 29	**36**	.....	
13	Beef (See note *a*.)	Tubes, 46 by 2cm	**Asbestus (tightly packed).**	15	July 31	Tubes 13 and 14 were sealed at the necks Aug. 2; 13 put in hood Mar. 1, 1881; removed Mar. 18, 1881. 14 put in hood, Mar. 1, 1881; removed, Mar. 18, 1881.	13	Nov. 24	**114 days until opened.**		Opened and exposed, Nov. 22, 1881; filamentous fungi seen Nov. 24, 1881.
14							14	1882. May 3	**637 days until opened.**		Opened and exposed, Apr. 29, 1882; cloudy, May 3, 1882.
15	Beef (See note *a*.)	Tubes, 46 by 2cm	**Charcoal, 30° to 100°**	15	Aug. 4		15	Aug. 6	2	.....	
16							16	Aug. 8	4	.....	
17	Beef (See note *a*.)	Tubes, 46 by 2cm	**Charcoal, 25° to 50°**	15	Sept. 1		17	Sept. 3	2	.....	
18							18	Sept. 2	1	.....	
19							19	Sept. 2	1	.....	
20			**Animal charcoal, coarse and fine, mostly 15°.**				20	Sept. 2	1	.....	
21							21	Sept. 2	1	.....	
22							22	Sept. 3	2	.....	
23						Tubes 23 and 24 were sealed at the necks Sept. 2.	23	Sept. 4	3	.....	
24							24	Sept. 4	3	.....	
25	Beef (See note *b*.)	Tubes, 46 by 2cm	**Animal charcoal, 100°.**	15	Oct. 23	Tubes 25 to 28 were warmed several times to hasten the filtration. Tube 27 sealed at the neck Dec. 15. Put in sterilized chamber, Mar. 1, 1881; removed, Mar. 18, 1881; opened and exposed, Apr. 29, 1882; no record of decomposition.	25	Dec. 7	45	.....	
26							26	Dec. 10	48	.....	
27							27	.....	**553 days until opened.**		
28							28	Dec. 13	51	.....	

29*c*	Milk	Tube, 46 by 2^{cm}	Asbestus (packed)	15	July 8		29	July 13	5	
30*d*	Hay (See note *a*.)	Tubes, 46 by 2^{cm}	Tightly Packed asbestus.	15	July 1		30*d*	July 21?	20?	
31*d*			Loosely Packed asbestus.				31*d*	July 6	5 days possibly.	
32			Sand, 30° to 50°				32	July 1		8
33							33			
34	Fish (See note *a*.)	Tubes, 46 by 2^{cm}	Asbestus (packed)	15	July 10	Tubes 34 and 35 warmed to hasten the filtration.	34	July 12	1	10
35			Sand, 100°				35	July 11	1	
36			Asbestus (packed)	15	July 14		36	July 15	1	12
37							37			
38*e*			Asbestus				38	July 14		6
39	Cucumber (See note *a*.)	Tubes, 46 by 2^{cm}	Asbestus (tightly packed).	15	July 22	Tubes 39 and 40 warmed very gently. Filtrations carried on very slowly.	39	July 28	6	
40							40	July 25	3	
41	Beet (See note *a*.)	Tubes, 46 by 2^{cm}	Asbestus (tightly packed).	15	July 22	Tubes 41 and 42 warmed very gently. Filtrations carried on very slowly.	41	July 29	7	
42							42	Aug. 2	11	
43	Putrid beef (See note *f*.)	Tubes, 46 by 2^{cm}	Sand, 25° to 40°	16	June 19		43*f*	See note *f*.	0	0
44				17			44*f*			
45			Sand, 100°	16			45*f*			
46				17			46	July 7	19	
47*g*	Putrid beef	Flask, 250^{cm3}	Sand, 100°	45	June 23		47*g*	See note *g*.	0	0

a The infusions Nos. 6 and 7 were exposed for six hours in evaporating dishes near old hay in a cellar. Those for Nos. 8 and 9 were exposed nine hours near old hay. Those for Nos. 10 to 24 and Nos. 30 to 38 were exposed in the laboratory over night in evaporating dishes. Those for Nos. 39 to 42 from 9 a. m. until 6 p. m. on the 22d instant in capsules.

b The infusions were filtered very slowly into all the tubes, but especially into Nos. 1 to 4 and 6 to 9, from one to four days being allowed for the filtration of about two inches of the infusions. Only a very small quantity of the infusion filtered through the fine sands of Nos. 3 and 4, as the tubes were not warmed. As the air of the tubes could only escape by forcing its way up through the mass of the filters, some difficulty was experienced in carrying on the filtrations through the very fine sands and charcoals, the air tending to raise the entire mass of the filters instead of slowly working its way through them in minute bubbles. The charcoal filters were accordingly forcibly pressed down by disks of copper gauze, fitted tightly into the tubes. As the infusions in Nos. 1 to 4 were slightly colored by copper salts, due to action of the infusions upon the copper gauze employed, Ex. 26, page 595, was made to determine whether the copper salts present had any effect in preventing the decompositions. In no cases, however, as was subsequently found, have the copper salts preserved the infusions. The infusions for Nos. 1 to 5 were exposed for several hours in evaporating dishes to the air of a stable-loft; those for Nos. 25 to 28 were exposed over night in the laboratory, and were diluted with tap-water before the filtrations.

c Filtered liquid was very thin and watery, the filter removing the greater portion of the fat and casein; evolved gas, and, upon being shaken, coagulated rapidly.

d No. 31 was clear on the 3d instant, and was not examined again until the 6th instant. No. 30 showed a very faint cloudiness on the 21st instant, but the traces of bacterial development were so very faint as to leave it doubtful for some time whether decomposition had actually set in or not.

e In No. 38 the infusion was not filtered, the tube being packed with asbestus after it was filled with the infusion, the object being to determine whether the presence of the asbestus column retarded the initiation of decomposition, affected its rate, &c.

f Nos. 1, 2, and 3 could not be filtered clear, and continued to decompose. Only a few drops passed No. 4, which remained clear until the 7th of July. The tubes were heated on a combustion-furnace for ten to fifteen minutes at as high a temperature as the glass would bear without softening.

g No. 5 could not be filtered clear. Apparatus arranged as in No. 5 of this table.

LIQUID-FILTRATIONS—Continued.

Filtrations of putrescible infusions through sterilized filters into sterilized empty tubes—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
48	Putrid beef....	Tube, 46 by 2cm.....	Asbestus (tightly packed).	15	1881. July 3	In Nos. 48 and 54 the infusions were filtered as completely as possible, and the tubes were dried just below the neck at a gentle heat to prevent subsequent infection of the filtered infusions by direct growths down the filters and sides of the tubes. No. 48, put in hood, Mar. 1, 1881; removed, Mar. 18, 1881; opened and exposed, Apr. 29, 1882; no record of decomposition. No. 54, put in hood, Mar. 1, 1881; removed, Mar. 18, 1881; opened and exposed, Apr. 29, 1882; faintly cloudy, May 6, 1882.	48	.....	665 days until opened.		
49*a*	Putrid beef....	Open tube, 60 by 1.3cm.	Asbestus (tightly packed).	50	July 12		49*a*	See note *a*.	0	0	
50	Putrid beef.... (See note *b*.)	Tubes, 46 by 2cm.....	Charcoal, 25° to 50°	15	Sept. 1		50*b*	See note *b*.	0	0	
51							51*b*				
52			Animal charcoal, coarse and fine, 15° mostly.				52*b*				
53							53*b*				
54	Hay	Tube, 46 by 2cm	Asbestus (tightly packed).	15	July 3		54	.....	665 days until opened.		
55	Beef.....	Fig. 1, Tubes, 46 by 2cm.	Spongy iron, 25° to 100°.	15	1881. Mar. 25	Heated for several hours in Carius oven at 210° C., after addition of hot filters. Filtration begun Mar. 25, 1881, and finished Mar. 26, 1881; necks sealed, March 28; in process of sealing 56, 57, 58 were broken at the neck, but the exposed ends were kept well within the flame; a portion of the infusion used was exposed and decomposition set in upon the evening of the first day.	55	.....	.....	.....	55 was opened Oct. 6, 1881, and filtered Nov. 18, 1881; filtrate contained no albuminoids, no phosphates; did contain sulphate of lime; no organic growths in iron, residue on filter; microscope shows no bacteria. 56 and 57 examined Dec. 1, chemically, with same result as in case of 55.
56							56				
57							57				
58							58				58, 59, and 60 opened Nov, 11, 1881; examined Dec. 1, like 55, with same results.
59							59				
60							60				

								1882.			
61							61	May 4	309	.....	Opened Apr. 29, 1882.
62							62	Unkno'n	.....	.....	Opened Oct. 12, 1881; liquid slightly alkaline.
								1881.			
63							63	Nov. 24	118	.....	Opened and exposed Nov. 18, 1881; filamentous fungi in decomposed liquid.
64							64	Nov. 24	118	.....	Opened and exposed Nov. 18, 1881; filamentous fungi in decomposed liquid.
65			Asbestus (packed)	15	June 29	Tubes were prepared in previous April; charcoal heated above 250°, asbestus ignited; tubes afterward heated to 275° for several hours. Filtration begun June 29, 1881; Nos. 70, 71, 72, did not filter well, the charcoal contracting and liquid running down sides of tube. Up to July 1, 1881, no liquid had passed 61 to 66; on July 1st 61 to 66 were warmed gently several times to aid filtration. July 7, 61 to 66 were warmed and filtered further; repeated filtration July 8, 61 to 66; July 9, 61 to 66 sealed and put in cultivating chamber.	65	Unkno'n	.....	.....	Opened and exposed Oct. 6, 1881; decomposition after addition of water on exposure; alkaline reaction; bacteria in decomposed liquid.
66							66	Unkno'n	.....	.....	Opened and exposed Oct. 4, 1881; slightly alkaline reaction; bacteria in decomposed liquid.
	Beef	Tubes, 18 by 1^{cm}									
67							67	July 9	10	.....	Bacteria found Oct. 16, 1881, on microscopical examination.
68							68	July 9	10	.....	Bacteria found Oct. 16, 1881, on microscopical examination.
69							69	July 9	10	.....	Bacteria found Oct. 16, 1881, on microscopical examination.
70			Animal charcoal, 100°.	15	June 29		70	Aug. 6	38	.....	Probably decomposed; microscopical examination, Oct. 16, 1881, showed no bacteria.
71							71	Aug. 6	38	.....	Probably decomposed; microscopical examination, Oct. 16, 1881, showed no bacteria.
72							72	July 7	8	.....	Microscopical examination, Oct. 16, 1881, showed no bacteria.

a A very putrid infusion was filtered through No. 7 to see whether the bacteria, odor, &c., could be removed by employing a longer filtering column. The first 100^{cm3} which passed the filter were clear and almost entirely devoid of odor. On standing exposed to the air decomposition set in again within sixteen hours. Subsequent portions filtered cloudy and retained more or less the putrid odor.

b Filtered cloudy, and continued to decompose.

Beef infusions, which were muddy from bacterial developments, were employed, and a hay infusion for No. 54, which had stood for several days exposed in a capsule. A portion of No. 47 was taken for No. 48.

LIQUID-FILTRATIONS—Continued.

Filtrations of putrescible infusions through sterilized filters into sterilized empty tubes—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
73	Beef, to which water from an open pail had been added.	Tubes	Carferal, 10° to 100°	15	1882. Apr. 18	Carferal heated for several hours at a temperature of 190°; the tubes at temperature of 160° to 175°, and for several hours more after insertion of the filter. Filtrations begun Apr. 18, continued Apr. 19 and 20; Apr. 21 filtrations continued with putrid beef infusion, that of the control tests of the series being used. Apr. 25, fresh beef juice added to 74 and 75.		1882.			
74							73	Apr. 26	8	.....	Distinctly cloudy.
75							74	Apr. 25	7	.....	Faint flakes of bacteria on Apr. 25, 1882.
76							75	.....	.....	.....	No record of decomposition.
77							76	Apr. 22	4	.....	Distinctly cloudy.
78							77	Apr. 21	3	.....	Distinctly cloudy.
79							78	Apr. 22	4	.....	Distinctly cloudy.
80							79	Apr. 22	4	.....	Distinctly cloudy.
							80	Apr. 22	4	.....	Distinctly cloudy.

LIQUID-FILTRATIONS—Continued.

Filtration of putrescible liquids through sterilized filters into sterilized infusions.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
1	Beef.....	Fig. 1, tube, 46 by 2^{cm}.	Spongy iron, 25° to 100°.	15	1881. Dec. 5	Dec. 5, put in cultivating chamber; Dec. 13, filtration begun (beef infusion); continued Dec. 14 (small quantity passing filters), Dec. 15, 16, 17 (Dec. 19 removed to lower hood). Further filtration of 10 and 11 in Dec. 19. Dec. 20, filtration of 7, 10, 11; also Dec. 23.	1	1881. Dec. 11	.....	.....	Decomposed before beginning of filtration; had been boiled 20 minutes in paraffine paste.
2							2	.....	.....	.....	
3	Beef.....	Fig. 1, tube, 46 by 2^{cm}.	Spongy iron, 10° to 80°.	15	Dec. 5		3	.....	.....	.....	
4							4	.....	.....	.....	
5	Beef.....	Fig. 1, tube, 46 by 2^{cm}.	Carferal, 10° to 100°.	15	1882. Apr. 7	Prepared (carferal heated to 185°–190° for more than four hours) and put in cultivating chamber Apr. 7, 1882; removed from cultivating chamber Apr. 15; filtration begun Apr. 18; Apr. 19, small quantity of fresh infusion passed filters; Apr. 20, filtration continued; Apr. 21, putrid infusion used, the infusion of the control test of this series of experiments being employed.	5	1882. Apr. 27	.....	.....	Cloudy near upper surface.
6							6	Apr. 30	.....	.....	Cloudy in upper layers.
7							7	Apr. 29	.....	.....	Cloudy in upper layers.
8							8	Apr. 21	.....	.....	Cloudy.
9							9	Apr. 29	.....	.....	Cloudy in upper layers.
10							10	Apr. 29	.....	.....	Cloudy in upper layers.

LIQUID-FILTRATIONS—Continued.

Filtrations of water into sterilized infusions.

[Nos. 1 to 57 appeared in former bulletin.]

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
1*a*, *c*	Beef	Fig. 1, tube, 46 by 2cm.	**Sand, 25° to 30°. Asbestus plug in neck of the tube.**	8	1880. Filled June 9	A few drops of water filtered through July 9.	1*a*, *c*	1880. July 11	2	.....	
2*b*	Beef	Tube, 150 by 1.25cm, and flask, 1 liter.	**Sand, 100°**	125	July 24	Filtration of water on the 26th instant.	2*b*	July 28	2	.....	
3*c*	Beef	Flask, 250cm3	**Sand, 30° to 50°**	5	July 27	Water added in just sufficient quantity to saturate the sand but not to filter through, August 3 and again August 13.	3*c*	Aug. 16	13?	.....	
4	Beef ..... (See note *c*.)	Tubes, 46 by 2cm	**Sand, 30° to 50°**....	15	July 13	Water added to Nos. 4 to 7 on August 13, 14, 15, and 16. A few drops filtered through No. 4 on the 16th instant, through Nos. 5 to 7 on the 19th instant.	4*c*	Aug. 17	**Less than 15 hours.**		
5							5*c*	Aug. 19	**Within 2 or 3 hours.**		
6							6*c*	Aug. 19	**Within 10 hours.**		
7							7*c*	Aug. 19			
8	Beef ..... (See note *d*.)	Tubes, 46 by 2cm	**Asbestus (tightly packed).**	15	July 23	Filtrations of water into the infusions on August 24, 26, 28, 30, 31, September 1 and 2.	8*d*	Sept. 7*d*	14	.....	
9							9*d*				
10	Cucumber .... (See note *d*.)						10*d*				
11							11*d*				
12	Beet ..... (See note *d*.)						12*d*	Unk'n*d*	**Unknown.**		
13							13*d*				
14	Beef ..... (See note *e*.)	Tubes, 46 by 2 cm.....	**Charcoal, 100°**	15	Aug. 3	Additions of water October 15, 16, 17, 18. A few drops of water percolated No. 15 on the 18th and No. 14 on the 19th instant.	14*e*	Oct. 26	7	.....	
15				7			15*e*	Oct. 22	4	.....	

16 17 18	Beef..... (See note *c*.)	Tubes, 46 by 2^{cm}....	**Animal charcoal, coarse and fine, mostly 15°.**	15	Aug. 28	Additions of water on October 15 and 16. A few drops filtered through on the 16th instant.	16*c* 17*c* 18*c*	Oct. 18	**1**	**12**
19 20 21 22	Beef..... [See note *f*.]	Tubes, 46 by 2^{cm}.....	**Animal charcoal, 100°.**	15	Oct. 19	Filtrations of water into Nos. 20 to 22 November 24, and into No. 19 November 27. Filtrations continued rapidly into Nos. 19 and 21 December 1, and into Nos. 19, 21, and 22 December 2, 3, 10, and 13, when the tubes were completely filled. Filtrations into No. 20 continued December 13, and carried on slowly. No. 20, in cultivating chamber, Apr. 19–21, 1881; on removal from cultivating chamber filter was found to be mechanically defective.	19*f* 20*f* 21*f* 22*f*	Dec. 14 ..... Dec. 15 Dec. 14	**17** **Fresh until filter became defective, Apr. 21, 1881.** **21** **20**	....
23 24 25	Beef..... (See note *g*.)	Tubes, 46 by 2^{cm}.....	**Charcoal, 25° to 50°.**	15	Oct. 19	Filtrations of water Nov. 23..	23*g* 24*g* 25*g*	Nov. 28	**4**	**12**
26 27 28 29 30 31	Beef..... (See note *h*.)	Tubes, 46 by 2^{cm}....	**Mixture of sand, 18° to 100°, 3 parts, and pure kaolin 1 part, by weight.**	15	Sept. 24	Additions of water to 26 to 28 on October 15 and 16. A few drops filtered through on the 16th instant. Filtrations of 26 and 27 continued on the 19th instant, as the infusions were still clear. Filtrations of 29 to 31 begun October 18 and continued until the 22d instant, when a small quantity was filtered through. Further filtration of 29 on the morning of the 25th instant, as the infusion remained clear.	26*h* 27*h* 28*h* 29*h* 30*h* 31*h*	Oct. 22 Oct. 20 Oct. 19 Oct 25 Oct. 23 Oct. 23	**6** **4** **3** **3** **1** **1**	.... **3** **12**

a See No. 14, page 594.

b In No. 2 the open tube was fitted air-tight into the flask by means of a rubber stopper. The stopper was provided with a second tube plugged with asbestus for steam-escape during ebullition and air-escape during filtration. The bacterial developments were very rapid and profuse.

c Bacterial growths very abundant.

d Tubes 8 to 13 were filled with water September 2. September 7 Nos. 8, 9, 10, and 11 showed *very faint* traces of bacterial growths. These growths have increased but very little since the 7th of September. The dates for Nos. 12 and 13 could not be determined, so faint were the signs of growths. The tubes were apparently perfectly clear for a month, and on December 18 No. 13 still showed only a *very slight* opalesence. Microscopical examination of No. 13 December 18 revealed but the merest traces of bacterial growths. Microscopical examinations of Nos. 8 and 9 December 23 revealed very feeble bacterial growths (*B. termo*, &c.)

e Bacterial growths distinct in No. 14 and abundant in No. 15. (Ordinary bacteria of putrefaction, *B. termo*, and also *B. lineola*.)

f The filtrations were carried on very rapidly in Nos. 19, 21, 22; bacterial development in No. 19 very slow. Examined under the microscope December 23. Bacterial growths in Nos. 21 and 22 distinct but not abundant. Microscopical examination January 26 (*B. termo*; *Micrococci*; *Bacillæ—Bacillus-ulna?*; *Spirilla—Spirillum-undula*).

g Bacterial growths very rapid.

h Decomposition rapid. Microscopical examinations of several of these infusions showed presence of *B. termo* and *Bacillæ*.

LIQUID-FILTRATIONS—Continued.

Filtrations of water into sterilized infusions—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
					1880.			1880.			
32*a*	Beef ..... (See note *b*.)	Tubes, 46 by 2^{cm}	**Mixture of sand, 18° to 100°, 1 part; kaolin, 1 part.**	15	Nov. 3	Filtration of water into Nos. 33 and 35 November 23, and into Nos. 32, 34, 36, and 37 November 24. The filter columns were kept saturated, and the filtrations proceeded very slowly from day to day.	32*a*,*b*	Dec. 14	20	.....	
33							33*b*	Dec. 1	8	.....	
34							34*b*	Dec. 2	8	.....	
35							35*b*	Nov. 27	4	.....	
36							36*b*			.....	
37							37*b*		3	.....	
38	Beef ..... (See note *b*.)	Tubes, 46 by 2^{cm}	**Kaolin**	15	Nov. 3	Filtrations of water into Nos. 38 to 41 and 43 November 24, and into No. 42 November 27. Filtrations continued very slowly from day to day.	38*b*	Nov. 29	5	.....	
39							39*b*	Nov. 30	6	.....	
40*a*							40*a*,*b*	Dec. 13	19	.....	
41							41*b*	Nov. 28	4	.....	
42							42*b*	Nov. 30	3	.....	
43							43*b*	Nov. 28	4	.....	
44	Beef ..... (See note *c*.)	Tubes, 46 by 2^{cm}	**Coal-ashes, 10° to 100°,**	15	Nov. 3	Filtrations of water begun November 23 and continued from day to day until decomposition ensued. Filtrations carried on rapidly December 2 and 3, the tubes being nearly filled. No. 49 was completely filled December 10.	44*c*	Dec. 4	11	.....	
45							45*c*	Dec. 4	11	.....	
46							46*c*	Dec. 7	14	.....	
47							47*c*	Dec. 3	10	.....	
48							48*c*	Dec. 9	16	.....	
49							49*c*	Dec. 12	19	.....	
50	Beef ..... (See note *b*.)	Tubes, 46 by 2^{cm}	**Loess, 100°**	15	Nov. 4	Filtrations of water begun November 23 and continued slowly from day to day until the infusions decomposed.	50*b*	Nov. 30	7	.....	
51							51*b*	Nov. 29	6	.....	
52							52*b*	Dec. 1	8	.....	
53							53*b*				
54							54*b*	Nov. 29	6	.....	
55							55*b*				

56*d*	Beef.....	Lead pipe, 23 feet by 1 inch, and flask, 1 liter. (See figure 4.)	**and, 18° to 100°...**	**22 feet..**	Sept. 6	Filtration September 13, 1,500^{cm3} of water being added.	56*d*	Sept. 15	2	.....
57*d*	Beef.....	Lead pipe, 101 feet by 1 inch, and flask, 1 liter. (See figure 4.)	**Sand, 18° to 100°...**	**100 feet.**	Sept. 24	Additions of water (well water containing fungoid growths, &c.): 1,000^{cm3}, October 18. 700^{cm3}, October 19. 300^{cm3}, October 20. 400^{cm3}, October 21. 400^{cm3}, October 22. 400^{cm3}, October 23. 300^{cm3}, October 24. 300^{cm3}, October 25. 260^{cm3}, October 26. 260^{cm3}, October 27. 260^{cm3}, October 28. 260^{cm3}, October 29. 260^{cm3}, October 30. 260^{cm3}, October 31. 240^{cm3}, November 1. 5,600^{cm3}. Some 100^{cm3} filtered into the infusion by midnight of November 1.	57*d*	Nov. 3	**Nearly 2.**	
					1881.					
58	Beef.....	Tube, 46 by 2^{cm}.....	**Spongy iron, 25° to 100°.**	15	Mar. 25		58	.....	.....	.....
59	Beef.....	Tube, 46 by 2^{cm}	**Spongy iron, 25° to 100°.**	15	Mar. 29	Put in cultivating chamber, Mar. 30, 1881; filtration continued almost daily from Apr. 9 to Apr. 29; removed from cultivating chamber May 4, the tubes being nearly full.	59	.....	.....	.....
60	Beef.....	Tube, 46 by 2^{cm}	**Spongy iron, 25° to to 100°.**	15	Mar. 29		60	.....	.....	.....
61	Beef.....	Tube, 46 by 2^{cm}	**Spongy iron, 25° to 100°.**	15	Mar. 29		61	.....	.....	.....
62	Beef.....	Tube, 46 by 2^{cm}	**Spongy iron, 25° to 100°.**	15	Mar. 29		62	.....	.....	.....
63	Beef.....	Tube, 46 by 2^{cm}	**Spongy iron, 25° to 100°.**	15	Mar. 29		63	.....	.....	.....

No. 58 appeared faintly cloudy; but when observed subsequently, on Oct. 6, 1881, no bacteria could be found.

a A few drops of water filtered through on November 24. Subsequently scarcely an appreciable amount passed the filters.
b Decomposition rapid. Microscopical examinations of several of these infusions showed presence of *B. termo* and *Bracillæ*.
c Bacterial growths slow, but finally profuse.
d In No. 56 the lead pipe was connected with the flask by a lead tube, 6 by ¼ inches, which was soldered to the pipe and passed air-tight through the rubber stopper of the flask. In No. 57 the lead tube did not enter the flask directly but was connected with a glass tube of same diameter, which passed through the rubber stopper by rubber tubing to which a pinch-cock was attached to control the flow of water into the infusion. The bacterial growths were very rapid and abundant in both flasks.

LIQUID-FILTRATIONS—Continued.

Filtrations of water into sterilized infusions—Continued.

No.	Infusion.	Dimensions of tubes, &c., employed.	Filters.		Date of experiment.	Subsequent treatment.	No.	Date of decomposition.	Time in—		Remarks upon decomposition.
			Kind.	Length in centimeters.					Days.	Hours.	
					1882.			1882.			
64	Beef	Tubes boiled in paraffine bath. Carferal heated more than four hours, at a temperature of 180°–185°. Tubes, 46 by 2cm.	Carferal, 10° to 100°	15	Apr. 7	Put in cultivating chamber, Apr. 7; removed Apr. 15; filtration of water from an open pail begun April 18; small quantity of it passed filters on Apr. 19; filtration continued Apr. 20, 21.	64	Apr. 21	3 days after filtration began.		Faintly cloudy.
65	Beef		Carferal, 10° to 100°	15	Apr. 7		65	Apr. 23	5 days after filtration began.		Cloudy.
66	Beef		Carferal, 10° to 100°	15	Apr. 7		66	Apr. 24	6 days after filtration began.		Faintly cloudy.
67	Beef		Carferal, 10° to 100°	15	Apr. 7		67	Apr. 23	5 days after filtration began.		
68	Beef		Carferal, 10° to 100°	15	Apr. 7		68	Apr. 21	3 days after filtration began.		
69	Beef		Carferal, 10° to 100°	15	Apr. 7		69	Apr. 25	7 days after filtration began.		

LIQUID-FILTRATIONS—Continued.

Rapid filtrations of water into sterilized infusions.

No.	Infusion.	Apparatus.	Filters.		Beginning of experiment.	Special treatment.	No.	Date of decomposition.	Time.	Remarks upon decomposition.
			Kind.	Length in centimeters.						
1	Beef.....	1-liter flask; filter tube 2 by 15cm.	Spongy iron, 20° to 30°.	15	1881. Oct. 15	Put in cultivating chamber, Oct. 15; removed, Oct. 22. Several hundred cm3 of water were rapidly filtered on Nov. 11.	1	1881. Nov. 12	Less than 24 hours after filtration.	Very turbid from bacterial growths.
2	Beef.....	1-liter flask; filter tube 2 by 15cm.	Spongy iron, 25° to 100°.	15	1882. Apr. 12	Put in cultivating chamber, Apr. 12; removed, Apr. 19. Filter was saturated, and 50 cm3 filtered through as rapidly as possible on Apr. 20. Filtration took only a few minutes. Put flask back into cultivating chamber.	2	1882. Apr. 21	The next day after filtration.	Heavy mycoderma.
3	Beef.....	1-liter flask; filter was heated six hours to 170°–190° C.; tube 2 by 15cm.	Carferal.....	15	Apr. 12	Put in cultivating chamber, Apr. 12; removed, Apr. 19. Filtration begun, Apr. 20. After saturation of filter, 50 cm3 were filtered through as rapidly as possible; but the filtration was nevertheless slow, and took several hours. Put back in cultivating chamber.	3	Apr. 21,	The next day after filtration.	Badly decomposed.

LIQUID-FILTRATIONS—Continued.

Capillary upward filtration of water through sterilized filters.

No.	Infusion.	Apparatus.	Filters.		Special treatment.	No.	Time in days from beginning of filtration.
			Kind.	Length in centimeters.			
1	Beef.....	Flask of Fig. 2, with tube *c*, replaced by an inverted U-tube whose arm exterior to the flask is filled to the arch, with sand resting upon a plug of loosely-packed asbestus, and dips beneath unsterilized water, the other arm being drawn out fine and passing through the stopper and packing of flask, and ending just above the infusion.	Sand, 100° and finer...	15	Prepared and put in cultivating chamber, **Sept. 8,** 1881; removed from cultivating chamber, Sept. 15; filtration begun Oct. 4; sand was saturated in 10 minutes, but no water passed over into infusion; a single drop of water was forced over into infusion by suction, Oct. 5, 7; several drops forced over Oct. 11, the flask being kept in the mean time in the cultivating chamber. Decomposed, **Oct. 13,** 1881.	1	9
2	Beef.....	As above.....	Sand, 100° and finer...	15	Prepared and put in cultivating chamber, **Sept. 8,** 1881; treatment as above. Decomposed, **Oct. 15,** 1881.	2	11
3	Beef.....	As above.....	Sand, 80° to 100°.....	15	Prepared and put in cultivating chamber, **Sept. 8,** 1881; treatment as above; the saturation of sand by capillarity took a longer time. Decomposed, **Oct. 13,** 1881.	3	9
4	Beef.....	As above.....	Sand, 80° to 100°.....	.....	Prepared and put in cultivating chamber, **Sept. 8,** 1881; treatment as in No. 3. Decomposed, **Oct. 13,** 1881.	4	9

Transmission of spores from liquids into air.

WITHOUT ASPIRATION.

[Nos. 1 to 6 appeared in table on page 23 of former bulletin.]

No.	Infusion.	Apparatus.	Beginning of experiment.	Special treatment.	Date of decomposition.	Time, days.	Remarks upon decomposition.
1	Beef.....	Fig. 5. Liter flask with bent tube (1^{cm} in diameter) as trap, containing water.	Aug. 5, 1880	Subjected to ordinary temperature, 20° to 37° C.	Nov. 5, 1880	92	
2	Beef.....	Fig. 5. Same apparatus, with trap containing beef infusion.	Aug. 5, 1880	Subjected to ordinary temperature, 20° to 35° C.	Aug. 25, 1880	20	Flask appeared to have been disturbed.
3	Beef.....	Fig. 5. Same apparatus, with trap containing urine.	Aug. 5, 1880	Subjected to ordinary temperature of the laboratory until Feb. 22, 1881; exposed in cultivating chamber on Feb. 22–23 to 40° to 42° C.; put in hood, Mar. 1, 1881; trap replenished June 21, 1881, Oct. 22, 1881.	.....	.....	**Not decomposed.**
4	Beef.....	Fig. 5. Same apparatus, with trap containing beef infusion.	Aug. 27, 1880	Subjected to ordinary temperature of laboratory, 20° to 37° C.	Nov. 18, 1880	83	
5	Beef.....	Fig. 5. Same apparatus, with trap containing beef infusion.	Aug. 27, 1880	Subjected to ordinary temperature of laboratory, which went as high as 43° C.	Dec. 22, 1880	117	
6	Beef.....	Fig. 5. Same apparatus, with trap containing sewage.	Aug. 27, 1880	Subjected to ordinary temperature of laboratory until Feb. 22, 1881; in cultivating chamber, Feb. 22–23, at 40° to 42° C.; in hood, Mar. 1; trap replenished, June 21, 1881.	.....	.....	**Not decomposed.**
7	Beef.....	Fig. 5. Same apparatus, trap containing water.	Feb. 25, 1881	Put in cultivating chamber; trap replenished Mar. 18, 1881, and flasks put on lower shelf of hood; traps replenished Oct. 22, 1881.	.....	.....	**Not decomposed.**
8	Beef.....	Fig. 5. Same apparatus, trap containing beef infusion.	Feb. 25, 1881		.....	.....	**Not decomposed.**
9	Beef.....	Fig. 5. Same apparatus, trap containing urine.	Feb. 25, 1881		.....	.....	**Not decomposed.**
10	Beef.....	Fig. 5. Same apparatus, trap containing sewage.	Feb. 25, 1881		.....	.....	**Not decomposed.**

11	Beef.....	Fig. 5. Same apparatus; trap contains sand, 10° to 100°; saturated with water.	May 4, 1881	Put in cultivating chamber, May 4, 1881; removed, June 21, 1881; traps replenished, June 21, 1881; all with sewage, Aug. 12, 1881; Oct. 6, 1881; Oct. 22, 1881; put in hood, Aug. 25, 1881.	Aug. 3, 1881	91	Defective, crack in trap-tube.
12	Beef.....	Fig. 5. Same apparatus; trap contains sand, 10° to 100°; saturated with beef-infusion.	May 4, 1881		Sept. 4, 1881	123	Accidentally broken.
13	Beef.....	Fig. 5. Same apparatus; trap contains sand, 10° to 100°; saturated with urine.	May 4, 1881		.....	.....	**Not decomposed.**
14	Beef.....	Fig. 5. Same apparatus; trap contains sand, 10° to 100°; saturated with sewage.	May 4, 1881		Mar. 8, 1882	308	Large fungi.
15	Beef.....	Fig. 5. Same apparatus; trap contains sand, 10° to 100°; saturated with fæces and urine.	May 4, 1881		Mar. 8, 1882	308	Large fungi; sand of trap not quite dry in uppermost inner layers.

Transmission of spores from liquids into air—Continued.

WITH ASPIRATION.

[Numbers 1 to 11 appeared in table on page 23 of old bulletin as numbers 7 to 17.]

No.	Infusion.	Apparatus.	Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
1	Beef.....	Fig. 6, flask (500^{cm3}), with U-tube (10 by 2^{cm}), as trap. Tube *b* ended just above surface of liquid; tube *c* ended near upper extremity of trap. Trap filled with beef infusion.	Prepared, **Aug. 12,** 1880; aspirated at ordinary temperature, 20°–35° C., Aug. 13–21, 24–29, 31; Sept. 21–25; kept in cultivating chamber, Feb. 22–23, 1881; traps replenished with putrid material, Mar. 29; aspirated in hood, Apr. 12–29; June 20–30; July 1, 2, 6–15; Aug. 4–19. (See table of temperatures.) Removed from hood, Aug. 25, 1881. **Not decomposed.**	91	344 In cul. ch., 216	**Not decomposed.**
2	.....	Fig. 6, apparatus as for No. 1. Trap filled with urine.	Prepared, **Aug. 12,** 1880; treatment like that of No. 1. **Not decomposed.**	91	344 In cul. ch., 216	**Not decomposed.**
3	.....	Fig. 6, apparatus as for No. 1. Trap filled with sewage, excepting that tube *b* ended near top of trap and tube *c* near surface of liquid.	Prepared, **Aug. 21,** 1880; aspirated at ordinary temperature, 20°–35° C., Aug. 24–29, 31; Sept. 1–17, 21–25; kept in cultivating chamber, Feb. 22, 23, 1881; trap replenished, Mar. 29; aspirated in hood, Apr. 12–21. (See table of temperatures.) Decomposed, **Apr. 21,** 1881.	39	140 In cul. ch., 38	Due to mechanical transfer of sewage to infusion (perhaps by bursting of bubbles or by films of liquid advancing along the tube). A drop of sewage was discovered upon the lower side of bend of trap.
4	Beef....	Fig. 6, flask (1 liter), with U-tube (10 by 2^{cm}), as trap. Tube *b* terminated in capillary size, below the surface of the liquid, in order to produce bubbling; tube *c* ended near surface of liquid, and the bend in it was moist. Trap filled with sewage.	Prepared, **Aug. 21,** 1880; aspirated at intervals, Aug. 24–28. Decomposed, **Aug. 29,** 1880.	5	A little more than 2.	
5	Beef.....	Fig. 7, flask (1 liter), with straight tube, as trap; otherwise like that of No. 4. Trap filled with sewage.	Prepared, **Sept. 7,** 1880; aspirated continuously and very slowly, at rate of about 333^{cm3} per diem, Sept. 14–25. At rate of about 870^{cm3} per diem, Oct. 18–31; Nov. 1–9. Decomposed, **Nov. 10,** 1880.	35	4 20	
6	Beef.....	Like that of No. 4, excepting that bend in tube *c* was kept dry and warm. Trap filled with sewage.	Prepared, **Sept. 1,** 1880; aspirated at intervals, Sept. 2–3. Decomposed, **Sept. 4,** 1880.	2	Less than 2	
7	Beef.....	Fig. 6, like that of No. 4, excepting that bend of tube *c* was kept warm and dry. Trap filled with beef infusion.	Prepared, **Sept. 6,** 1880; aspirated at intervals, Sept. 13–15. Decomposed, **Sept. 16,** 1880.	3	300^{cm3}	

Transmission of spores from liquids into air—Continued.

WITH ASPIRATION—Continued.

No.	Infusion.	Apparatus.	Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
8	Beef.....	Fig. 6, flask (1 liter), with tube *c*, 25cm in length. *No trap.* Tube *c* kept moist by addition of drop of water from time to time.	Prepared, **Sept. 1,** 1880; aspirated continuously, at average rate of 1,848cm3 per diem, Sept. 2–14. Decomposed, **Sept. 15,** 1880.	13	24	
9	Beef.....	Fig. 6, like that of No. 8, excepting that *c* was drawn out to a capillary tube for 10cm of its length and allowed to dry.	Prepared, **Aug. 28,** 1880; aspirated continuously, at average rate of 1.6 liters per diem, Aug. 31; Sept. 1–4. Decomposed, **Sept. 4,** 1880.	5	8	
10	Beef.....	Fig. 6, apparatus like that of No. 1, but with no asbestus in tube *b*. Flask, 500cm3. Trap filled with water. Tube *c* remained moist.	Prepared, **Sept. 2,** 1880; aspirated continuously, at average rate of 1.8 liters per diem, Sept. 3–12. Decomposed, **Sept. 13**, 1880.	10	18	
11	Beef.....	Fig. 6, apparatus like that of No. 4. Flask, 500cm3. Trap filled with sterilized (boiled) water. No asbestus in tube in *b*.	Prepared, **Sept. 2,** 1880; aspirated at intervals, Sept. 3–12. Decomposed between **Sept. 25** and **Oct. 13,** 1880.	10	24	
12	Beef.....	Fig. 6, apparatus like that of No. 1. Unsterilized water used in trap.	Prepared, trap filled with sterilized water, and put in cultivating chamber, **Feb. 24,** 1881; unsterilized water added, Mar. 29; aspirated in hood, Apr. 12–29; June 20; unsterilized water added, June 21; aspirated in hood, June 21–30; July 1, 2, 6–15; Aug. 4–19. (See table of temperatures.) Temperature from July 16 to Aug. 3 was that of laboratory. Removed from hood, Aug. 25.	57	216	**Not decomposed.**
13	Beef.....	Fig. 6, apparatus like that of No. 1. Putrid beef infusion used in trap.	Prepared, trap filled with sterilized water, and put in cultivating chamber, **Feb. 26,** 1881; putrid beef infusion put in trap, Mar. 29; aspirated in hood, Apr. 12–29; June 20; putrid beef infusion put in trap, June 21; aspirated, June 21–30; July 1, 2, 6–15; Aug. 4–19. (See table of temperatures.) From July 16 to Aug. 3 temperature was that of laboratory. Removed from hood Aug. 25.	57	216	**Not decomposed.**

14	Beef.....	Fig. 6, apparatus like that of No. 1. Putrid sewage and urine used in trap.	Prepared, trap filled with sterilized water, and put in cultivating chamber, **Feb. 26, 1881**; sewage, &c., added to trap, Mar. 29; aspirated in hood, Apr. 12–29; June 20; sewage, &c., added June 21; aspirated in hood, June 21–30; July 1, 2, 6–15; Aug. 4–19. (See table of temperatures.) Between July 16 and Aug. 3 temperature was that of laboratory. Removed from hood Aug. 25.	57	216	**Not decomposed.**
15	Beef.....	Fig. 6, apparatus like that of No. 1. Fresh fæces and urine used in trap.	Prepared, trap filled with sterilized water, and put in cultivating chamber, **Feb. 26, 1881**; fæces and urine put in trap, Mar. 29; aspirated in hood, Apr. 12–29; June 20; fæces and urine added to trap, June 21; aspirated in hood, June 21–30; July 1, 2, 6–15; Aug. 4–19. (See table of temperatures.) Between July 16 and Aug. 3 temperature was that of laboratory. Removed from hood Aug. 25.	57	216	**Not decomposed.**
16	Beef.....	Fig. 6, apparatus like that of No. 1. Sand, 10° to 100°, used in trap, and this saturated with unsterilized water.	Prepared and put in cultivating chamber, **May 4, 1881**; removed from cultivating chamber and put unsterilized water in traps, June 21; aspirated at temperature of laboratory, June 23–30; July 1, 2, 6–15; Aug. 4–16. Decomposed, **Aug. 15, 1881.**	33	64	
17	Beef.....	Fig. 6, apparatus like that of No. 1. Trap filled with sand, 10° to 100°, and this saturated with fæces and urine.	Prepared and put in cultivating chamber, **May 5, 1881**; removed from cultivating chamber and put fæces and urine in trap, June 21; aspirated at ordinary temperature, June 23–30; July 1, 2, 6–15; Aug. 4–19; chloride of calcium tubes attached, Aug. 25; aspirated in hood, Aug. 25–27; Sept. 6–10, 13–16, 21–23; Oct. 4–6. (See table of temperatures.) Trap replenished, Oct. 6; aspirated in hood, Oct. 7; crack discovered in rubber connector, Oct. 7. Decomposed, **Oct. 8, 1881.**	55	Total, 200 In hood, 64	Accidental breakage.
18	Beef.....	Fig. 6, apparatus like that of No. 1. Trap filled with sand, 10° to 100°, and this saturated with urine.	Prepared and put in cultivating chamber, **May 5, 1881**; removed from cultivating chamber and urine put in trap, June 21; aspirated at ordinary temperature, June 23–30; July 1, 2, 6–15; Aug. 4–19; chloride of calcium tube attached, Aug. 25; aspirated in hood, Aug. 25–27; Sept. 6–10, 13–16, 21–23; Oct. 4–6. (See table of temperatures.) Trap replenished, Oct. 6; aspirated, Oct. 7, 11–19; crack discovered in rubber connector and moisture appeared in upper part of U-tube. It is known that upper part of U-tube was dry on Oct. 17, so that it is probable that unfiltered air had not entered up to that time. Decomposed, **Oct. 19, 1881.**	64	Total, 236 In cul. ch., 100	Accidental breakage.

Transmission of spores from liquids into air—Continued.

WITH ASPIRATION—Continued.

No.	Infusion.	Apparatus.	Special treatment.	Number of aspirations.	Number of liters aspirated.	Remarks upon decomposition.
19	Beef.....	Fig. 6, apparatus like that of No. 1. Trap filled with sand, 10° to 100°, and this was saturated with putrid beef infusion.	Prepared and put in cultivating chamber, **May 4,** 1881; removed from cultivating chamber and saturated sand in trap with putrid material, June 21; aspirated at ordinary temperature, June 23–30; July 1, 2, 6–15; Aug. 4–19; chloride of calcium tubes attached, Aug. 25; aspirated in hood, Aug. 25–27; Sept. 6–10, 13–16, 21–23; Oct. 4–6; sand in trap resaturated, Oct. 6; aspirated in hood, Oct. 7, 11–22; sand in trap resaturated, Oct. 22; aspirated in hood, Oct. 23–25; stood in hood, to allow traps to dry, Oct. 26 to Dec. 14; aspirated in hood, Dec. 14, 18–22; resaturated sand in trap, Jan. 5, 1882; aspirated in hood, Feb. 16–23; Mar. 8–15.	92	346 After attaching chloride of calcium tube, 210 Over dried sand, 82	**Not decomposed.**
20	Beef.....	Fig. 6, apparatus like that of No. 1. Trap filled with sand, 10° to 100°, and this was saturated with sewage.	Prepared and put in cultivating chamber, **May 5,** 1881; removed from cultivating chamber and saturated sand in trap with putrid material, June 21; aspirated at ordinary temperature, June 23–30; July 1, 2, 6–15; Aug. 4–19; chloride of calcium tube attached, Aug. 25; aspirated in hood, Aug. 25–27; Sept. 6–10, 13–16, 21–23; Oct. 4–6; sand in trap resaturated, Oct. 6; aspirated in hood, Oct. 7, 11–22; sand in trap resaturated, Oct. 22; aspirated in hood, Oct. 23–25; stood in hood, to allow trap to dry, Oct. 26 to Dec. 14; aspirated in hood, Dec. 14, 18–22; resaturated sand in trap, Jan. 5, 1882; aspirated in hood, Feb. 16–23.	34	Total, 316 Subsequent to attaching the chlor. of cal. tube, 180 Over dry sand in trap, 52	**Not decomposed.**

Temperature of cultivating chamber.

[Centigrade thermometer.]

Day of month.	1881.											1882.						Day of month.
	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
1	.....	37½—42	44 —40	42 —42	.....	40 —40½	.....	41 —41½	38 —41	37 —37	38 —39	39 —39½	39 —41	38½—38	.....	39½—39	38 —38	1
2	.....	42 —40	40—40—41	41 —41¾	.....	41 —42	.....	40½—40¾	41 —40	37½—37	40 —41	38½—39	41 —40	37 —38	.....	37½—38	38½—38	2
3	.....	38 —40	40½—40	41¾—42	.....	41 —42	.....	40 —40½	39 —39½	.....	40 —40	40 —40½	39½—41	37½—37¼	.....	38 —36½	37 —36½	3
4	.....	38 —40	39 —37½	42 —42	.....	41 —42	.....	41 —42	35 —	.....	39½—40	41 —42½	40½—	36 —41	.....	35 —36	34½—34½	4
5	.....	40 —43	37 —37	42 —41½	.....	42 —42	.....	41½—gas out.	39½—40	.....	40 —41	41 —	37½—39	40¼—40¼	38½—38½	36 —37	34¼—34¾	5
6	.....	41 —41	37 —37	40 —40	.....	41½—41½	.....	—40½	41 —40	.....	40 —40	.....	41 —	39 —39¼	36 —38	37½—38	34½—	6
7	.....	40 —39	37 —37	40 —40¼	.....	41 —40	.....	41 —40½	35 —40	.....	37 —37½	.....	.....	40 —42	38 —40	39 —39	.....	7
8	.....	37½—39	40½—40½	40 —40	.....	39½—40	.....	41 —40½	40 —37	.....	37 —40	.....	.....	41½—43	42 —41	39 —38	.....	8
9	.....	38 —41	41 —41	40¾—40	.....	40½—40½	.....	40½—41	39 —40	.....	38 —40½	.....	.....	40 —38	39 —38	36 —37	34 —37	9
10	.....	41 —42	41 —41	40 —40	.....	40¼—37	36½—	41 —	39 —41	.....	40 —41	.....	38 —41	36 —39	37 —37	37½—38	37¾—38½	10
11	.....	36 —44	41¼—42	40 —40	.....	38½—40	36 —38	.....	41½—41	—31	40 —42	.....	42¾—42	40 —40½	36½—38	38 —38½	40 —40	11
12	.....	40 —	42 —42	40¾—41	.....	40¼—40	38 —38	41 —41	40½—40	32 —38	41 —40	.....	40 —39½	40 —38	38½—39	38 —	40 —39	12
13	.....	38½—	41¾—41	40 —40	.....	40 —33	38 —40	41 —41⅛	39 —38½	39 —38½	39½—39	40 —37	38 —38	37 —38	39 —40	.....	38½—38	13
14	.....	40 —43	41¼—40½	40 —39	.....	40 —41	40 —40	42 —42	40½—40½	37 —41½	38 —38½	38 —42	37½—39	38 —41	41 —41	.....	37½—	14
15	.....	41½—43	39 —41	38 —37	.....	41½—41½	39½—40	42 —40½	40 —39	40 —42	39 —40½	42 —41½	38½—39	41 —	41 —40	.....	.....	15
16	.....	36 —39	41 —42	38 —37	.....	.....	39 —39	41 —41	39½—40	42 —39	40 —41	40½—41	39 —	.....	39 —38½	.....	.....	16
17	.....	37½—48	42 —43	38 —39	.....	.....	31 —31	41 —41	40 —39	40 —39	40 —40	42 —44	—39½	.....	37 —37½	.....	.....	17
18	.....	47 —39	42½—42½	39½—39	.....	.....	Gas out —35	40 —40	38 —38½	37¼—40	38½—40	44 —42½	40 —41	40 —41	37½—38½	.....	.....	18
19	.....	36 —39	43 —42	39 —39	.....	.....	39 —40	38 —39	40 —40½	36½—37¼	40 —40	42 —43	39½—39	39 —40	38½—37½	.....	.....	19

Temperature of cultivating chamber—Continued.

Day of month.	1881.											1882.						Day of month.
	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
20	.....	32½—47	42 —42	39 —39	.....	.....	39 —40½	38½—39	40 —40	38 —38¾	39 —39	43½—42	37½—39	39½—39	37 —39	.....	.....	20
21	.....	37 —43	41½—41¾	39½—40	.....	.....	39½—41	39½—40	40½—40½	37 —36	39¼—40	41 —39	38 —35	38½—39	39½—40	.....	.....	21
22	38—40	37 —39½	41¾—41½	40 —40	.....	.....	40½—42½	40 —40	40¾—40	38½—46	38¾—37	39 —40	36 —37	39 —	39½—39	.....	.....	22
23	40—42	35 —43	41 —42	40 —40	.....	.....	41 —42	39½—39	40 —39½	42½—38½	36 —38	40 —42	37 —38	.....	37½—38	—42	.....	23
24	40—	41 —40½	41¾—40	41 —40	.....	.....	42 —41	39 —39¾	38½—37½	36 —40	41 —42¾	40½—44½	38 —39½	.....	37 —37½	39 —37	.....	24
25	39—	40 —41	40¾—41	40 —40½	.....	.....	41 —41	39 —39¼	37 —39½	42 —42	42 —42½	42¾—42½	39½—40½	.....	37 —37	35 —33½	.....	25
26	40—	31 —39	40 —40	40 —40	.....	.....	41 —41	39 —40	41 —41	40 —40	41 —41	40¼—40	39½—40	.....	36 —36	33 —33	.....	26
27	40—42	38 —39	40¼—40¼	39 —	.....	.....	41 —42	39 —39½	41½—40	39½—39½	39½—39	38¾—42	39 —39½	.....	33½—36	34 —36	.....	27
28	39—40½ —42	40 —41	40 —40½	.....	.....	.....	41 —42	39 —39¼	41 —38	40½—42	39¼—40½	41½—40	40 —40	.....	38 —40	37 —38½	.....	28
29	.....	41 —42	40 —41	.....	.....	.....	41¾—42¾	41 —40	37½—	41 —40½	39½—37	39 —40½	.....	.....	40 —41	40 —	.....	29
30	.....	40 —39½	42 —42	.....	39—40	.....	42 —	39 —40	.....	40 —40	36 —38	41 —41	.....	.....	39½—41	.....	.....	30
31	.....	39½—42	.....	.....	.....	.....	41½—41¾	.....	.....	.....	37½—39	40¼—38	.....	.....	.....	.....	.....	31

Temperature of hood.

Day of month.	1881. February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	1882. January.	February.	March.	April.	May.	June.	Day of month.
1	.....	.....	40 —42	39½—45½	.....	55 —55	.....	.....	—54	.....	55 —55	.....	42 —45	31½—36½	.....	38 —36	33 —33	1
	.....	.....	36 —38	39 —44	.....	51 —50	.....	52 —54	—50	.....	52 —51	.....	40 —42½	34 —36½	.....	38 —38	34 —35	
2	.....	.....	37 —42	40 —42	.....	53 —55	.....	.....	54 —54	.....	51 —51	.....	45 —45	36 —37	.....	33 —31	35 —33	2
	.....	36 —37	33 —39	38 —40	.....	49 —50	.....	52½—51	49 —50	.....	46 —48	.....	42 —43	37 —40	.....	35 —33	35½—34	
3	.....	.....	39 —46	42 —43	.....	54 —55	.....	.....	54 —54	.....	55 —55	.....	43 —46	36 —35	.....	33 —33	33 —35	3
	.....	35 —40½	35 —42	40 —40	.....	51 —50	.....	49 —49	49 —50	.....	52 —50	.....	41 —44	39 —36	.....	35 —35	35 —35	
4	.....	.....	40 —45	42 —45	.....	54 —58	25 —51	.....	54 —49	.....	51 —52	.....	40 —	37 —41	.....	33 —37	34 —35	4
	.....	33 —35	36 —40	37½—40	.....	51 —53	25 —48	50 —51	50 —45	.....	48 —51	.....	37 —	36 —39	.....	35 —36	35 —36	
5	.....	.....	37 —42	43 —44	.....	55 —56	53 —56	.....	40 —52	.....	.....	.....	40 —43	42 —43	39 —32½	35 —37	34 —35	5
	.....	34 —35	33 —38	39 —41	.....	51 —52	50 —52	50 (gas out).	40 —47	.....	.....	.....	38 —42	40 —42	31 —32½	35 —38	36 —36	
6	.....	.....	36 —44	40 —42	.....	57 —59	55 —55	48 —51	51 —52	.....	.....	52 —49	43 —43	39 —41	32 —30	35 —37	34 —36	6
	.....	30 —33	32 —39	37 —38	.....	55 —54	51 —52	45 —47	46 —47	.....	.....	49 —46	41 —40	37 —40	31 —32	36 —38	35 —35	
7	.....	.....	41 —45	40 —45	.....	55 —56	55 —55	51 —54	36 —55	.....	.....	50½—52	43 —45	38 —38	30 —33	35 —35	35 —35	7
	.....	37 —36	37 —41	37 —42	.....	52 —51	51 —52	49 —50	35 —50	.....	.....	48 —49	40 —42	37 —38	31 —36	36 —36	36 —36	
8	.....	.....	41 —46	40 —45	.....	53 —55	53 —51	52 —49	58 —55	.....	.....	52 —52	43 —45	34 —37	33 —36	33 —36	36 —35	8
	.....	31½—36	37½—42	38 —43	.....	49 —50	49 —51	49 —45	54 —51	.....	.....	48 —50	41 —42	36 —37	36 —39	34 —37	37 —36	
9	.....	.....	44 —45	41 —45	.....	53 —55	53 —53	47 —49½	59 —57	.....	.....	52 —45	44 —34	35 —35	32 —32	35 —40	35 —36	9
	.....	—41	40 —41	38 —43½	.....	49½—50	49 —49	44 —45½	53½—51	.....	.....	48 —48	41 —38	37 —36	36 —34	36 —40	33 —36	
10	.....	43 —44	41 —42	42 —47	.....	53 —46	54 —56	49 —	56 —51	.....	.....	47 —39	30 —33	35 —37	27 —29	37 —35	35 —37	10
	.....	40 —42	37 —37	42 —46	.....	49 —44	50 —52	45 —	52 —47	.....	.....	49 —42¾	33 —34	35 —36	28 —31	37 —36	35 —37	
11	.....	39 —40½	38 —44	44 —50	.....	43 —53	53 —55	.....	51 —51	—46	—45	35 —48	33 —35	35 —37	30 —32	30 —33	35 —37	11
	.....	36 —37	34 —40	42 —46	.....	41 —49	49 —50	.....	47 —46	—44	—45	38 —44	34 —33	35 —35½	33 —35	36 —39	35 —36	
12	.....	41 —	40 —43	45 —48	.....	54 —52	51 —53	48 —48	50 —51	52 —53½	51 —52	43 —46	35 —34	35 —38	30 —28	32 —	33 —36	12
	.....	39 —	35 —39	45 —50	.....	50 —48	50 —49	45 —44	46 —46	52 —53½	49 —51	48 —47½	35 —35½	34 —37	33 —31	34 —	34 —35	
13	.....	.....	42 —43	42½—47	.....	52 —30	52 —55	48 —48	52 —53	56 —58	54 —52	44 —44	31 —33	36 —30½	29 —31	.....	36 —37	13
	.....	42.2—	37 —39	44 —50	.....	49 —28	48 —51	44 —44	48 —45	53 —53	52 —52	46 —47	33 —35	36 —31	32 —34	.....	36 —37	

Temperature of hood—Continued.

Day of month.	1881.											1882.						Day of month.
	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	
14	.....	42 —45½	41 —41	43 —48	.....	47 —58	55 —56	46 —47	50 —48	51 —51	55 —58	44 —44	34 —37	35 —39	32 —32	.....	35 —37	14
	.....	—43	36 —37	42 —47	.....	47 —53	51 —51	43 —43	43 —48	49 —52	53 —44	48 —47	35 —36	33 —37	34 —34	.....	36 —37	
15	.....	43 —45	37 —44	41 —47	—41	56 —57	52 —50	45 —52	50 —50	48½—53½	52 —50	43 —45	33 —35	36 —35	30 —33	.....	36 —37	15
	.....	40 —42	32 —39	40 —45	—39	53 —53	48 —47	42 —47	46 —48	50½—50	49 —50	47 —47	35 —36	35 —34	33 —36	.....	36 —37	
16	.....	39 —42	39 —45	38 —43	39 —41	.....	49 —47	51 —54	55 —55	54 —55	51 —55	43 —50	33 —35	32 —32	30 —29	.....	36 —	16
	.....	36 —39	39 —41	38 —43	37 —39	.....	44 —42	47 —49½	51 —49	53 —51	50 —52½	47 —47½	34 —35	32 —31	34 —31	.....	37 —	
17	.....	36 —	40 —41	36 —43	49 —53	.....	29 —35	53 —55	55 —52⅔	56 —55	56 —56	44 —45	35 —31	31½—33	27 —29	.....	.....	17
	.....	34 —	37 —38	34 —39	45 —48	.....	27 —33	48 —50	48 —48½	54 —53	51 —53	45 —45	34 —33	31 —35	31 —31	.....	.....	
18	.....	43 —45	37 —44	35 —40	51½—52	.....	—38	53 —54	55 —54	55 —57	56 —55	46 —43	32 —34	30 —33	32 —34	.....	.....	18
	.....	40 —40	35 —41	34 —40	49 —48	.....	—35	49 —49	48 —43	53 —53	53½—50	44 —46	31 —31	30 —33	35 —36	.....	.....	
19	.....	40 —42	41 —41½	42 —49	49 —52	.....	50 —52	51 —55	51 —52	.....	55 —54	45 —46	32 —37	32 —39	34 —34	.....	.....	19
	.....	—39	38 —38	37 —42	47 —49	.....	45 —48	46 —50	49 —47	.....	53 —52	46 —48	30 —36	31 —38	36 —36	.....	.....	
20	.....	35 —41	38 —43	42 —48	50 —52	.....	.....	55 —57	51 —52	.....	52 —55	41½—48	36 —38	37 —35	34½—37	.....	.....	20
	.....	32 —37½	34 —38½	41 —45	48 —48	.....	.....	51 —52	48 —47	.....	59½—52	44 —48	34 —36	37 —35	36½—38	.....	.....	
21	.....	38 —43½	39 —41½	41 —46	49½—51	.....	.....	54 —52	51 —52½	.....	53 —52½	48 —47	36 —37	30 —36	33 —33	.....	.....	21
	.....	35 —40	35 —38½	40 —45	47 —47	.....	.....	49 —47	49 —47	.....	51 —51	48 —48	35 —35	32 —37	35 —35	.....	.....	
22	.....	35 —43	38 —39	41 —46	46 —53	.....	.....	51 —52	55 —54	—52½	53 —54	43½—40	35 —37	33 —	34 —35	.....	.....	22
	.....	31 —38	33 —36	39½—45	43½—48	.....	.....	47 —47	48 —46	—51	50½—52	47 —40	34 —35	33 —	36 —36	.....	.....	
23	.....	36 —45	36 —41	41 —46	50½—52	.....	.....	53 —52	53½—52	50 —55	54 —	48 —47	37 —35	.....	33½—35	—30	.....	23
	.....	32 —41	33 —37	40 —44	47 —49	.....	.....	49 —48	47 —44	46 —53	52 —	44 —42	34 —33½	.....	35 —36	—30	.....	
24	.....	39 —46	37 —40½	43 —48	51 —54	.....	.....	55 —54	54 —54	55 —56	.....	43 —47	32 —36	.....	33½—35	30 —33	.....	24
	35—	35 —41	36 —36½	40 —45	48 —50	.....	.....	51 —49	44 —47½	51½—53	.....	38 —43	30 —34	.....	35 —36	30 —33	.....	
25	.....	43 —44	39 —41½	41 —46	52 —54	.....	—42	54 —55⅓	50½—51	49 —51	.....	48 —52½	35 —	.....	33 —35	32 —30	.....	25
	35—45	39 —39	36 —36	40 —45	49 —49	.....	—40	50 —50½	42½—44½	51 —51	.....	44 —48	34 —	.....	34 —35	33 —32	.....	
26	42 up to	37 —43	35 —41	40 —46	53—55—54	.....	42 —47	55 —55¾	47 —41	51 —53	.....	47 —52	.....	.....	33 —36	30 —33	.....	26
	65	32 —37	32 —38	39½—44	50—50—48	.....	40 —44	51½—51	46 —45	51 —52½	.....	42 —49	.....	.....	34 —37	31 —30	.....	

| | | |

Variation of temperature of hood by periods.

[Centigrade thermometer.]

Date.	Min.	Max.	Mean.
1881.			
February 22 to April 30	30	46	37
May 1 to May 27	34	50	43
May 28 to June 14	Ordinary temperature.		
June 15 to June 30	37	58	49
July 1 to July 15	28	59	52
July 15 to August 4	.....	.....	.....
August 4 to August 31	25	56	46
September 1 to September 30	42	57	49.7
October 1 to October 29	35	59	50.9
November 11 to November 30	44	58	52.2
December 1 to December 23	45	58	51.8
1882.			
January 7 to January 31	35	52.5	44.9
February 1 to February 28	30	46	36.6
March 1 to March 22	30	41	35.6
April 5 to April 30	27	40	33.1
May 1 to May 31	29	40	34.4
June 1 to June 16	33	37	35.4

INDEX.

Page.

Adamstown, Md. (*see* Report on water analysis) 295
Alabama, laws of, relating to public health and the collection of vital statistics. 378
Albuminoid-ammonia, process of water analysis 228–231
Ammonia, collection of 312–345
Andover, Mass. (*see* Report on water analysis) 293
Annual report 7–47
  Special scientific investigations 7
  Vital statistics, collection of 11
  Operations of the Board, maritime quarantine 13–28
  International quarantine inspections 24
  Rules and regulations for securing the best sanitary condition of vessels, &c 19
  Inter-State quarantine 29
  Illinois State board of health, resolutions of 31
  Immigrant inspection service 32
  Instructions to inspectors of immigrants 34
  Legislation, amendments recommended 36
  Miscellaneous operations of the Board:
    Quarantine at San Francisco, Cal 37
    Aid to the District of Columbia 38
    Aid to Pensacola, Fla 39
    Yellow fever at Brownsville, Tex 39
    Bulletin, concerning publication of 41
    Grounds of opposition to the National Board of Health 43
    Statement of expenditures of the Board 45
    Estimates submitted 47
Appendix A.—Report on the nature of diphtheria, by Drs. H. C. Wood and H. F. Formad 51–133
  Diphtheritic membrane, structure of 51–54
  Clinical relations of micrococci to diphtheria 55–66
  Cases of diphtheria studied in Philadelphia 58–66
  Natural history of micrococci 66–75
    I. Morphology of micrococci:
      A. Recognition of micrococci 66
      B. Micrococci as observed in epidemic diphtheria, &c 67
      C. Methods and objects of culture 68
      D. Biology of diphtheritic micrococci as observed in culture 69
    II. Culture experiments 71–75
  Relation of the micrococci to diphtheria 75
  Inoculation with diphtheritic matter—results of experiments 79–133
Appendix B.—Reports on siphonage of traps, by George E. Waring, jr., and by E. S. Philbrick and E. W. Bowditch 135–152
  Experiments, results of, on siphonage of traps, Waring 135–145
    Philbrick and Bowditch .. 146–152
Appendix C.—Report on inspection of health resorts, by E. W. Bowditch, sanitary engineer 153–187
  Sanitary condition of Newport, R. I 153–157
    Analysis of drinking water 166–172
  Atlantic City 157–159
  Long Branch, Monmouth Beach, and Seabright 159, 160
  Bar Harbor 161–163
Appendix D.—Water analysis, by Prof. J. W. Mallet, F. R. S., University of Virginia 189–353
  1. Preliminary report as to the chemical methods in use for the determination of organic matter in potable water 189–211
  2. Report as to chemical methods, &c 212–345
  3. Report of results of a supplementary investigation as to chemical methods in use, &c 346–353

Page.

Appendix D—Continued.
Classes of water examined 216
Summary of processes in use 217–231
Ignition process 219, 220
Combustion process 221–224
Permanganate process 225–227
Albuminoid-ammonia process 228–231
Classified list of waters examined:
I. Natural waters believed from actual use to be of good, wholesome character 290–292
II. Natural waters supposed to have caused disease in those drinking them 292–297
III. Natural waters of doubtful but more or less suspected character ... 297–301
IV. Artificially prepared waters made by adding to good, wholesome water determinate quantities of various infusions of vegetable organic matter of natural origin 301, 302
V. Artificially prepared waters, as above, made with various forms of vegetable refuse from manufacturing or industrial operations 302, 303
VI. Artificially prepared waters, as above, made with animal (or partly animal) organic matter of natural origin 303
VII. Artificially prepared waters, as above, made with animal refuse from manufacturing or industrial operations 303
VIII. Artificially prepared waters, as above, to which had been added morbid products from certain diseases in the human subject 304
Details of the re-examination of certain waters 307–312
Supplementary report on water analysis 346–353
Details of experiments on distillation and condensation of known quantities of ammonia 312–314
Details of collection of ammonia 314–345
Appendix E.—Registration of vital statistics, by John S. Billings, surgeon United States Army 355–461
Registration in Mexico 360
Registration in the United States and certain foreign countries, tables relating to 368–374
Registration laws in the several States 378–452
Appendix F.—Correspondence with the governor of Louisiana 463
Appendix G.—Report of operations at Ship Island refuge station, by Dr. T. S. Scales, superintendent 465–474
Report on vessels inspected 465–467
Origin of yellow fever at Pensacola 467–469
Intercourse with mainland, how maintained 469
Fees for fumigation of vessels 469
Public property, condition of 469
Resolution of the board of health of Harrison County, Mississippi, relative to the management of Ship Island station 469, 470
Letter of Dr. E. Lathain, president of board of health of Hancock County, Mississippi, relative to benefits of Ship Island station 470
Letter of E. F. Griffin, president board of health of Jackson County, Mississippi, in support of management of Ship Island station 470, 471
Vessels inspected, list of 472, 473
Appendix H.—Report of operations at Sapelo Sound refuge station, by Dr. W. H. Elliott, superintendent 475, 476
Appendix I.—Maritime sanitary service of the United States and the relations of national and State authorities, by Dr. Stephen Smith 477–484
International sanitary co-operation 478
Sanitary information, collection and distribution of 479
Maritime sanitary rules and regulations 480
Maritime sanitary inspections 480
Sanitary care of vessels arriving at the ports of the United States 481
Co-operation of national with State and municipal authorities 483
Absence of quarantine and inadequate quarantine regulations 483
Conclusions—functions of national and State sanitary service in their relations to each other 483, 484
Appendix K.—Report on the Mississippi River inspection service, by Dr. Fayette Dunlop, superintendent 485–487
Inspections made at Vicksburg and Memphis 485
Sickness among employés 486
The sanitary fleet, its condition, &c. 486
Property of Board on Mississippi River, condition of 486
Public confidence in the service 487

Page.
Appendix L.—Report of Dr. S. E. Chaillé on inspection service at New Orleans 489–543
The National Board and the board of health of Louisiana, correspondence of Dr. Chaillé with the governor of Louisiana and the health authorities of New Orleans 489–495
Yellow fever in New Orleans in 1882 498–512
Inspection of passengers required by the Mississippi State board of health .505, 514
The inspection service at New Orleans 512
Mississippi River quarantine service 513
River service, inspection of freight 513, 541
Railroad service, inspection of freight 513, 541
Report of Dr. G. F. Patton on operations at Mississippi River quarantine station 515, 540
Report of Drs. P. B. McCutchon and F. W. Parham on river inspection service 541
Reports on railroad inspections at New Orleans, by Drs. L. F. Salamon, J. M. Watkins, S. C. Russell, Henry Bezou, and S. R. Oliphant 541–543
Appendix M—Immigrant inspections 545, 569
Report of Dr. J. H. Rauch, supervising inspector 545–564
Letter of Dr. J. Fourness Brice, senior surgeon steamship Germanic 565
Report of Dr. J. J. Mulheron, inspector at Detroit, Mich 566
Letter of Dr. William Smith, health officer at New York 567–569
Appendix N.—Quarantine at San Francisco, Cal 571–578
Letter of F. A. Bee, Chinese consul, relative to small-pox among immigrants on board steamship Altonower, and their treatment 571
Extract from Petaluma (Cal.) Argus relative to small-pox among Chinese immigrants 572
Extract from Berkeley (Cal.) Beacon on same subject 572
Report on quarantine at San Francisco 573
Letter from committee of board of health of San Francisco 577
Appendix O.—Second report on the filtering capacity of soils, by Raphael Pumpelly assisted by Dr. George A. Smyth 579–664
Summary of former report 580–583
Second report—continuation of experiments:
I. Filtration of air through dry filters of spongy iron 584
II. Slow quantitative air filtration 585–588
III. Rapid quantitative air filtration 589
IV. Filtration of putrescible infusions 590
V. Filtration of water 590
VI. Capillary filtration 591
VII. Transmission of spores from liquids into air 591
VIII. Experiments to determine the presence of bacteria in dry soils at various depths 592
Passive air-filtrations, wet filters 602, 603
Summarized statement of experiments:
Passive air-filtrations, dry filters 594–601
Quantitative air-filtrations, dry sterilized filters 604–609
Quantitative air-filtrations, unsterilized filters 610
Quantitative air-filtrations, filters moistened with sterilized water 611–614
Quantitative air-filtrations, filters moistened with unsterilized water 615
Quantitative air-filtrations, filters moistened with putrescible liquids 616
Quantitative air-filtrations through open tubes with disk of gauze 630
Quantitative air-filtrations, rapid dry sterilized filters 632–638
Liquid filtrations into sterilized empty tubes 639–644
Liquid filtrations into sterilized infusions 645–651
Liquid filtrations, capillary upward filtration 652
Transmission of spores from liquids into air without aspiration 653
Transmission of spores from liquids into air with aspiration 655–658
Temperature tables 659–664
Asbury Park, N. J. (*see* Report on water analysis) 296
Atlantic City, sanitary condition of 157–159
Baltimore, water supply of (*see* Report on water analysis) 292
Bar Harbor, sanitary condition of 161–163
Bee, F. A., Chinese consul, relative to treatment of small-pox cases among Chinese immigrants in San Francisco Harbor 571
Berkeley (Cal.) Beacon on the treatment of small-pox among Chinese immigrants 572
Bemiss, Dr. S. M. (*see* Report on water analysis) 300
Bezou, Dr. Henry, report on inspection of railroad passengers at New Orleans. 543
Billings, Dr. John S. (*see* Report on registration of vital statistics) 355–461

Page.
Births, deaths, and marriages, registration of (*see* Report on vital statistics). 355–461
Black, Dr. J. E., inspector at President's Island station 485
Board of health of Harrison County, Mississippi, resolution of, in support of Ship Island station 469, 470
Board of health of San Francisco, letter of, relative to quarantine 577
Bordentown, N. J. (*see* Report on water analysis) 299
Boston, water supply of (*see* Report on water analysis) 292
Bowditch, E. W., sanitary engineer, report on siphonage of traps 146–152
Report on inspection of health resorts 153–187
Brice, Dr. J. Fourness, vaccination on shipboard 565
Brown, Dr. H., United States Army, results of investigations of, with respect to quarantine 14, 15
Brownsville, Tex., yellow fever at 39
Brumbaugh, Dr. A. B. (*see* Report on water analysis) 296
Burlington, Vt., water supply of, (*see* Report on water analysis) 293
California, laws relative to registration of vital statistics 379
Care of vessels arriving at ports of the United States 481
Carter, Dr. J. L. (*see* Report on water analysis) 299
Carter, Dr. W. D. (*see* Report on water analysis) 298
Cate, Dr. H. J. (*see* Report on water analysis) 299
Chaillé, Dr. S. E., report on inspections at New Orleans 489–543
Charleston, S. C., water supply of (*see* Report on water analysis) 290
Charlotte, Mich. (*see* Report on water analysis) 295
Chicago, Ill., water supply of (*see* Report on water analysis) 292
Chicago, Saint Louis and New Orleans Railroad, freight inspections 541
Passenger inspections 543
Classified list of waters examined 290–304
Closter, N. J. (*see* Report on water analysis) 298
Collection and distribution of sanitary information 479
Combustion process of water analysis 221–224
Connecticut, laws concerning the registration of births, marriages, and deaths. 381
Coonley, Dr. E. D. (*see* Report on water analysis) 293
Co-operation of national with State and municipal authorities 483
Craig, Dr. G. G. (*see* Report on water analysis) 294
Crary, Dr. H. A. (*see* Report on water analysis) 298
Dallas, Tex. (*see* Report on water analysis) 299
Deaths, registration of, (*see* Report on vital statistics) 335–461
Delaware, laws concerning registration of births and deaths 384
Details of the re-examination of certain waters 307–312
Dibrell, Dr. J. A., jr. (*see* Report on water analysis) 294
Diphtheria, report on by Dr. H. C. Wood and H. F. Formad 51–133
Cases of, studied in Philadelphia 58–66
Origin of, bibliography 75–78
Endemic, results of experiments 79-93
Epidemic, results of experiments 94–120
District of Columbia, aid to 38
Dorsey, Dr. R. W. (*see* report on water analysis) 293
Drew, Dr. C. (*see* report on water analysis) 295
Drinking water of Newport, analysis of 166–172
Dungan, Dr. D. H. (*see* Report on water analysis) 294
Dunlap, Dr. Fayette, report on Mississippi River inspection service 485–487
Elliott, Dr. W. H., report on Sapelo Sound refuge station 475, 476
England, laws providing for the registration of vital statistics 452
Estimates of expenditure for the year ending June 30, 1884 47
Expenditures of the National Board of Health 45
Experiments on distillation and condensation of known quantities of ammonia. 312
Evans, Dr. S. T. (*see* Report on water analysis) 298
Fairfax Court-House, Va. (*see* Report on water analysis) 293
Fees for fumigation of vessels at Ship Island station 469
Filtering capacity of soils, report on 579–664
Formad, Dr. H. F. (*see* Report on diphtheria) 51–133
Freight, inspection of, at New Orleans 513, 541
Georgia, laws relating to public health 387
Gibbons, Dr. Henry, jr., extracts from letter of, regarding quarantine at San Francisco 575
Hancock County, Mississippi, president of board of health of, indorses management of Ship Island station 470
Hargis, Dr. R. B. S., statement concerning origin of yellow fever at Pensacola 468

Page.
Harris, Dr. M. B. (*see* Report on water analysis) 293
Harrisonburg, Va., public spring water (*see* Report on water analysis)..... 292
Harrison County, Mississippi, resolution of board of health of, relative to management of Ship Island station 469, 470
Hartwell, Dr. E. M. (*see* Report of Prof. J. W. Mallet on water analysis) .234, 275, 286
Hatton, E. A. (*see* Report on water analysis) 302
Health resorts, report on, E. W. Bowditch 153–187
Hewes, F. S., Secretary board of health of Harrison County, Mississippi, transmitting resolution supporting management of Ship Island station. 469
Hobart, Thomas L. (*see* Report on water analysis)..... 292, 299
Horlbeck, Dr. H. B. (*see* Report on water analysis) 290
Hudson, River water (*see* Report on water analysis) 299
Huntingdon, Pa. (*see* Report on water analysis) 296
Ignition process of water analysis..... 217–220
Illinois State board of health, resolutions addressed to the governor of Louisiana, respecting inter-State traffic during the epidemic season..... 31
Illinois, laws establishing a board of health and providing for the collection of vital statistics 389
Immigrants, inspection of 32
Immigrants, inspection of, for the purpose of preventing the introduction of small-pox 545–569
Inadequate quarantine regulations..... 483
Indiana, regulations of State board of health concerning the collection of vital statistics..... 393
Information, sanitary, collection and distribution of..... 479
Inspection of health resorts, report on 153–187
Inspections, maritime sanitary 480
Inspections on Mississippi River 485–487
Inspection of passengers at New Orleans 505
Inspectors of immigrants, instructions to 34
International quarantine inspections 24
International sanitary co-operation..... 478
Inter-State quarantine 29
Iowa, laws relating to the State board of health and the registration of vital statistics 394
Jackson County, Mississippi, president board of health of, indorses management of Ship Island station 470, 471
Jacksonville, Fla. (*see* Report on water analysis)..... 295
Johnson, Dr. W. H. (*see* Report on water analysis)..... 295
Jonesville, Mich. (*see* Report on water analysis) 295
Kentucky, laws concerning the registration of births, marriages, and deaths .. 395
Lake Drummond water, Dismal Swamp, Va. (*see* Report on water analysis)..... 302
Latham, Dr. E., president board of health of Hancock County, Mississippi, letter of, in support of management of Ship Island station 470
Legislation, amendments recommended 36
Lexington, Mich. (*see* Report on water analysis) 296
Little Rock, Ark. (*see* Report on water analysis)..... 294
Long Branch, Monmouth Beach, and Seabright, sanitary condition of..... 159, 160
Longstreet, Dr. H. H. (*see* Report on water analysis) 299
Louisiana, correspondence with governor of, relative to quarantine regulations. 463
Louisiana, laws concerning the registration of births, marriages, and deaths .. 396
Louisville and Nashville Railroad, freight inspections..... 542
Passenger inspections 543
Lowry, Dr. M. J. (*see* Report on water analysis)..... 296
Ludington, Mich., epidemic of diphtheria at, investigations of Drs. Wood and Formad 93–97
Maine, laws concerning the registration of births, marriages, and deaths..... 400
Mallet, Prof. J. W. (*see* Report on water analysis) 189–353
Maritime sanitary service of the United States, and the relations of national and State authorities..... 477–484
Mariner's Harbor, N. Y. (*see* Report on water analysis)..... 293
Maritime sanitary rules and regulations 480
Marriages, registration of (*sse* Report on vital statistics) 355–461
Martin, Prof. J. Newell (*see* Report of Prof. J. W. Mallet on water analysis) .232, 265, 275, 286, 287–289
Maryland, laws concerning the registration of births, marriages and deaths... 401
Massachusetts, legislation concerning the registration of births, marriages, and deaths from 1639 to 1880..... 403–411
McCarrell, Dr. J. (*see* Report on water analysis) 294

Page.
McCutchon, Dr. P. B. report on river inspections 541
McEnery, Hon. S. D. correspondence relating to quarantine regulations..... 463
Meridian, Miss. (*see* Report on water analysis) 296
Micrococci, clinical relations of, to diphtheria..... 55–66
Micrococci, natural history of..... 66–75
Michigan, laws concerning the registration of births, marriages, and deaths... 411
Minnesota, laws relating to the collection of statistics, and the registration of births, marriages, and deaths..... 416
Mississippi River inspection service, report on..... 485–487
Mississippi River water at New Orleans (*see* Report on water analysis) 300
Mississippi State board of health, action of, relative to inspection of passengers at New Orleans 505
Missouri, report concerning registration of vital statistics 418
Mitchell, Dr. Henry (*see* Report on water analysis)..... 296
Morphology of micrococci..... 66–75
Mount Vernon, Ohio (*see* Report on water analysis) 294
Mulheron, Dr. J. J., report on inspection of immigrants at Detroit, Mich..... 566
National Board of Health, concerning opposition to..... 43
National Board of Health, expenditures of..... 45
National and State authorities, relations of, as to maritime sanitary service..477–484
National health organization, functions of, in relation to State Boards 483
Neilson, Dr. J. L., assistant surgeon, United States Navy (*see* Report on water analysis) 300
New Hampshire, laws providing for the registration of births, marriages, and deaths..... 419
New Jersey, laws relating to the registration of births, marriages, and deaths. 420
New Orleans, water supply of (*see* Report on water analysis)..... 292
Inspections at 489–543
Correspondence of Dr. S. E. Chaillé with health authorities of 490–496
Yellow fever at, in 1882 498–505
Newport, R. I., (*see* Report on water analysis) 300
Newport, R. I., report on sanitary condition of, by E. W. Bowditch, S. E..... 153–180
New York, laws providing for the registration of births, marriages, and deaths. 427
New York City, water supply of (*see* Report on water analysis) 292
North Carolina, law providing for the registration of vital statistics 429
Noyes, William A. (*see* Report of Prof. J. W. Mallet on water analysis).232, 275, 276, 281
Ockford, Dr. George M. (*see* Report on water analysis)..... 293
Ohio, laws relating to the registration of vital statistics..... 429
Oldfield, Dr. A. M. (*see* Report on water analysis)..... 296
Olliphant, Dr. S. R., report on inspection of steamboat passengers at New Orleans 543
Oregon, laws relating to marriages 431
Parham, Dr. F. W., report on river inspections..... 541
Passengers, inspection of, at New Orleans 505, 514
Patton, Dr. G. F., report on operations at Mississippi River quarantine station 515–540
Pensacola, Fla., aid to 39
Origin of yellow fever at 467–469
Pennsylvania, laws providing for the registration of vital statistics..... 432
Permanganate process of water analysis 225–227
Petaluma (Cal.) Argus on the treatment of small-pox among Chinese immigrants 572
Peterman, Dr. C. P. (*see* Report on water analysis) 294
Philadelphia, water supply of (*see* Report on water analysis)..... 292
Philbrick, E. S., C. E. Report on siphonage of traps 146–152
Port Chester, N. Y. (*see* Report on water analysis)..... 297
Portsmouth, Va., water supply of (*see* Report on water analysis)..... 302
Poughkeepsie, N. Y. (*see* Report on water analysis)..... 298
Public property at Ship Island station, condition of 469
Pumpelly, Prof. R., Report on filtering capacity of soils..... 579–664
Quarantine, result of, investigations by Dr. Brown, United States Army 14, 15
Quarantine regulations inadequate 483
Quarantine service, Mississippi River..... 513
Quarantine at San Francisco, report on..... 37, 571–578
Rand, Dr. W. H. (*see* Report on water analysis) 295
Rauch, Dr. J. H., report on immigrant inspections..... 545–564
Registration of vital statistics, report on 355–461
Registration of vital statistics in England, laws concerning 452
Registration in Mexico..... 360

Page.
Registration laws in the United States 378–452
Relations of national and State authorities and the maritime sanitary service of the United States 477–484
Resolutions of the board of health of Harrison County, Mississippi, indorsing the management of Ship Island station 469, 470
Resolutions of Illinois State board of health concerning inter-State traffic during epidemic season, addressed to the governor of Louisiana 31
Rhode Island, history of legislation concerning registration of vital statistics, with statutes from 1698 to 1852 437–441
Report on the filtering capacity of soils by Prof. R. Pumpelly 576–664
Reports on inspection of immigrants 545, 569
Report on inspections at New Orleans by Dr. S. E. Chaillé 489–543
Report on inspection of certain health resorts by E.W. Bowditch, S. E 153–187
Report on Mississippi inspection service by Dr. Fayette Dunlap 485–487
Report on nature of diphtheria by Drs. H. C. Wood and H. F. Formad 51–133
Report on quarantine at San Francisco 573, 577
Repcrts on railroad inspections at New Orleans 541–543
Report on river inspections at New Orleans 541
Report of Dr. G. F. Patton on Mississippi River quarantine service 515–540
Report on the registration of vital statistics by Dr. J. S. Billings, surgeon United States Army 355–461
Report on sanitary condition of summer resorts 153–187
Report on sanitary condition of Newport, R. I., Bowditch 153–180
Report on water analysis, Mallet 189–353
Richmond, Va., water supply of (*see* Report on water analysis) 292
Ripley, Miss. (*see* Report on water analysis) 298
Rock Island, Ill., water supply of (*see* Report on water analysis) 294
Rules and regulations for securing the best sanitary condition of vessels, &c ... 19
Russell, Dr. S. C., report on inspection of railroad passengers at New Orleans. 543
Salamon, Dr. L. F., report on railroad freight inspections 541
Sanitary condition of summer resorts, report on 153–187
Sanitary information, collection, and distribution of 479
Sanitary inspections, maritime 480
Sanitary rules and regulations, maritime 480
Sapelo Sound refuge station, report on, by Dr. W. H. Elliott 475, 476
San Francisco, quarantine at 37, 571–578
Scales, Dr. T. S., report of operation at Ship Island refuge station 465–474
Sexton, Dr. Luther, inspector at Vicksburg station 485
Ship Island refuge station, report on 465–474
Siphonage of traps 135–152
Small-pox, regulations adopted to prevent the introduction of 32
Small-pox, reports upon service organized to prevent introduction of, into the United States 545–569
Small-pox among Chinese immigrants in San Francisco Harbor 571–578
Smart, Charles, surgeon, United States Army (*see* Report of Prof. J. W. Mallet on water analysis) 233, 275, 276, 279, 282, 283, 350–352
Smith, Dr. Stephen, report on maritime sanitary service of the United States, and the relations of National and State authorities 477–484
Smith, Dr. William M., health officer of New York, views of, relative to the inspection of immigrants 567–569
Smyth, Dr. George A., report on filtering capacity of soils 579–664
Soils, filtering capacity of, report on 579–664
South Carolina, law providing for the registration of births, marriages, and deaths 441
Southworth, Dr. M. S. (*see* Report of Prof. J. W. Mallet on water analysis) 232
State sanitary organizations, functions of, in relation to national organization .. 484
State board of health of Mississippi, resolutions of, concerning inspection of passengers at New Orleans 505
Sternberg, George M., surgeon, United States Army; (*see* Report of Prof. J. W. Mallet on water analysis) 286
Storer, Dr. H. R. (*see* Report on water analysis) 300
Strayer, H. V. (*see* Report on water analysis) 292
Structure of diphtheritic membrane 51
Summer resorts, sanitary condition of, report on, by E. W. Bowditch 153–187
Sutherland, Dr. C., surgeon, United States Army, report on quarantine at San Francisco 573
Tables relating to registration in the United States and certain foreign countries 368–374

Page.
Tanner, Dr. J. T., United States Navy (*see* Report of Prof. J. W. Mallet on water analysis) 233, 274, 280, 282, 284
Tennessee, laws relating to the registration of births, marriages, and deaths... 443
Texas, laws relating to the registration of vital statistics 446
Titusville, Pa., water from driven wells 292, 299
Tomlinson, F. C. (*see* Report on water analysis) 298
Traps, siphonage of, reports on 135-152
Trinity River water (*see* Report on water analysis) 299
Union City, Tenn. (*see* Report on water analysis) 298
University of Virginia, water supply of (*see* Report on water analysis) 291, 301
Vaccination of immigrants (*see* Reports on immigrant inspections) 545, 569
Van Sant, Dr. John, surgeon, United States Marine Hospital Service, report on quarantine at San Francisco 573
Vermont, laws providing for the registration of births, marriages, and deaths. 446
Vessels inspected at Ship Island station 472, 473
Vessels inspected at Vicksburg and Memphis 485
Vessels, sanitary care of 481
Virginia, laws providing for the registration of births, marriages and deaths.. 448
Vital statistics, registration of, report on, by Dr. J. S. Billings 355-461
Laws, regulating collection of, in—
Alabama 378
California 379
Connecticut 381
Delaware 384
Georgia 387
Illinois 389
Indiana 393
Iowa 394
Kentucky 395
Louisiana 396
Maine 400
Maryland 401
Massachusetts 403
Michigan 411
Minnesota 416
Missouri 418
New Hampshire 419
New Jersey 420
New York 427
North Carolina 429
Ohio 429
Oregon 431
Pennsylvania 432
Rhode Island 437
South Carolina 441
Tennessee 443
Texas 446
Vermont 446
Virginia 448
Wisconsin 450
Waring, George E., jr., report on siphonage of traps 135-145
Warren, Dr. H. M. (*see* Report on water analysis) 295
Washington, D. C., water supply of (*see* Report on water analysis) 292
Water analysis, report on, Mallet 189-353
Waters examined 290-304
Watkins, Dr. J. M., report on railroad freight inspections 542
Wellsville, Ohio (*see* Report on water analysis) 294
West, M. O. (*see* Report on water analysis) 297
Wisconsin, laws providing for the registration of births, marriages, and deaths. 450
Wood, Dr. G. W., surgeon, United States Navy, report on quarantine at San Francisco 573, 576
Wood, Dr. H. C. (*see* Report on diphtheria) 51-133
Yellow fever in New Orleans in 1882 498-505
Yellow fever, origin of, at Pensacola 467-469
Yellow fever at Brownsville, Tex 39

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